SEL

2020 CATALOG

VERKAUF
SOLUÇÕES INTEGRADAS

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2020 TECHNOLOGY HIGHLIGHTS

TIME-DOMAIN LINE PROTECTION

Discover the SEL-T400L Time-Domain Line Protection, an ultra-high-speed transmission line relay, traveling-wave fault locator, and high-resolution event recorder. (Page 40)

ULTRA-HIGH-SPEED PROTECTION

Meet the SEL-T401L Ultra-High-Speed Line Relay, which combines time-domain technologies and high-performance distance elements for a complete protection and monitoring system. (Page 44)

ADVANCED GENERATOR PROTECTION

Provide advanced generator, bus, transformer, and auxiliary system protection for hydro, thermal, and pumped-storage applications with the new SEL-400G. (Page 22)

WIRELESS FAULT DETECTION

Apply the SEL-FT50 and SEL-FR12 Fault Transmitter and Receiver System to speed up distribution protection with fault indication in 6 ms. (Page 109)

CAPACITOR BANK CONTROL

Enhance your distribution system using the new SEL-734W Capacitor Bank Control with wireless current sensors to improve power quality. (Page 115)

CYBERSECURITY SOLUTIONS

Build strong cyber defenses and maintain ongoing security with fewer resources. (Page 240)

SEL ICON®

Deterministic wide-area networking solution for high-performance protection applications. (Page 186)

SOFTWARE-DEFINED NETWORKING

Improve local-area networking with deny-by-default cybersecurity and fast failover. (Page 188)

POWERMAX® SOLUTIONS

Intelligent control for seamless islanding as well as comprehensive generation and load management. (Page 235)

ON THE COVER

The country of Belgium is taking an ambitious leap toward integrating offshore wind energy into the European grid. Read how Belgian grid operator Elia partnered with SEL to implement a special protection system to ensure stable delivery of this renewable power.

Read the story at: **selinc.com/featured-stories/elia**

"Integrating our offshore wind energy into the European grid has improved the future security of supply of electricity for a wide region."

—**Rodolphe Hanuise**
Elia Project Manager

Elia Project Manager Rodolphe Hanuise and SEL Project Engineer Milind Malichkar at a substation in Brugge, Belgium.

LETTER FROM THE PRESIDENT

SEL endeavors to make electricity safer, more reliable, and more economical. We work hard and team up with you to create VALUE for you and our electricity-dependent society.

Our industry has traditionally created value by aggregating demand, so less capital and operating expenses would be incurred fulfilling the demand. That's still valid, but today we're also creating value by aggregating SUPPLY…turning clean but intermittent sources of energy into more-deterministic resources.

Both aggregations depend on the miracle we share: moving energy at the speed of light. Only the electric power industry moves its commodity that fast! Dependably and securely speeding up protection, control, and automation makes electric power even more valuable.

Our T400L relays have proven their value with fast, secure, and dependable operation around the world. We used to consider trip times in cycles—now in milliseconds and microseconds. A median operating time for the time-domain and traveling-wave elements is around 2.5 milliseconds…like moving from a car to a jet! Every time I learn of a new event, I can't wait to study it, because microsecond sampling to 18 bits of precision is giving us new insights time after time. Observing breaker restrikes, getting outstanding fault locations in milliseconds, seeing lightning-induced waves that don't result in faults, and many other phenomena. And, series capacitors just "disappear" because the elements are so fast!

In 2020, we will be releasing the T401L. It builds on the success of the T400L by including more-traditional but very much improved "phasor-based" elements. We've integrated the best of both worlds for outstanding performance under all conditions, and for all applications.

I've insisted that the fastest relays in the world need to ship the fastest. So, we ship T400L relays FROM STOCK. We'll be doing the same for the T401L. We're already shipping many popular products from stock, making it better, cheaper, faster, simpler to handle opportunities and emergencies, reduce your inventories, and speed up your projects. Check out our ship-from-stock offerings, and consider putting that to work for you.

We're also delighted to be introducing our 400G Advanced Generator Protection System. It covers both the generator and step-up transformer, including two differential zones; tracks frequency from 5 Hz to 120 Hz; simplifies pumped storage by eliminating external switching; and has many capabilities to increase machine life before serious damage occurs.

In distribution, we are speeding up protection with our FT50 Fault Transmitters and FR12 Fault Receivers. These are also providing tremendous VALUE, saving the installation of primary equipment, speeding up protection when there's no need to wait for fuses, and helping pin down faults faster…in 6 milliseconds!

Our designers have mastered the art of energy harvesting for radio communications and expanded the state of the art for capacitor bank control. Our wireless current sensors pair up with the 734W Capacitor Bank Control, so you can measure currents at one point and voltages at another…and optimize voltage profiles in your control schemes.

We've dedicated tremendous effort to cybersecurity solutions and services. The ICON time-division-multiplexed systems and the SDN packet-based systems have complementary advantages as well as their unique capabilities. For example, ICON provides terrestrial time distribution, and SDN provides deep-packet inspection at the front end. Both systems share fast healing, deterministic performance, high quality, dependability, and high levels of inherent security.

Finally, I'd like to emphasize our efforts to provide 24/7 service. We want to be of help wherever you are, at any time of the night or day. We are "there" for you, when you need a question answered, have a problem, or need something in a hurry. We love teaming up with you to provide the best value, moving energy at the speed of light.

Thank you for your confidence and trust in SEL.

Sincerely,

Edmund O. Schweitzer, III
President
Chief Technology Officer

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ABOUT SEL

OUR MISSION—MAKING ELECTRIC POWER SAFER, MORE RELIABLE, AND MORE ECONOMICAL

SEL invents, designs, manufactures, and supports a complete line of products and services for the protection, monitoring, control, automation, and metering of electric power systems. Our solutions range from comprehensive generator and transmission protection to distribution automation and control systems.

SEL teams offer services, education, and support for a variety of industries and throughout the power system. Our Engineering Services team provides engineering expertise and system solutions to customers worldwide. SEL University offers training that helps our customers meet the technical challenges of integrating digital technologies into their expanding power system infrastructure.

OUR HISTORY

Edmund O. Schweitzer, III, founded SEL in 1982 in Pullman, Washington. SEL introduced the world's first digital protective relay to the electric power industry in 1984. The SEL-21 revolutionized the power protection industry by providing fault locating and real fault data at a much lower cost than traditional electromechanical relays. Today, we continue to set the standard for technology with the introduction of the world's fastest transmission line relay, the SEL-T400L Time-Domain Line Protection.

As part of a long-term strategy for sustained growth, stability, and customer focus, SEL became an employee-owned company in 1994 and transitioned to 100 percent employee ownership in 2009. Our ownership value is at the heart of our employees' hard work to reduce costs, increase quality, and create the superior products that enable us to fulfill our mission.

1984
SEL-21

TODAY
SEL-T400L

INDUSTRIES WE SERVE

From the beginning, we've provided solutions for electric utilities. As our company has grown, so have our product portfolio and the number of industries we serve. From airports and hospitals to the power grids of entire countries, SEL solutions are protecting and controlling critical operations around the world.

Electric Power Generation

Power Transmission and Distribution

Oil, Gas, and Petrochemical

Renewable Energy

Metals and Mining

Water and Wastewater

Pulp and Paper

Mission-Critical Power Systems

Government

Education and Healthcare

Consumer Product Manufacturing

Transportation

ENGINEERING IS OUR MIDDLE NAME

At SEL, we are passionate about our work, knowing it contributes directly to improving the reliability of electric power, keeping people safe, and helping customers conserve resources through efficiency, simplicity, and creativity.

We develop innovative products and services by focusing on the challenges our customers face. This helps us create the best solutions for a wide range of industries and applications. Every day, SEL engineers create new technologies and solutions to solve our industry's challenges.

OUR COMMITMENT TO QUALITY

Because SEL equipment becomes part of critical—and complex—infrastructure, from the electric power grid to processing and manufacturing facilities, we focus on long-term reliability and quality.

We warranty our products for 10 years and design them to last more than 20 years, and after serving our customers for more than 30 years, we still don't charge for repairs—regardless of the age of the product. Our free repair policy generates useful data that we use to drive product and service improvements. Constant improvement is an integral part of quality at SEL because of the lives and critical infrastructure our products protect.

"As engineers, we work every day to invent, design, and support products that monitor, control, and protect power systems installed all over the world. Serving our industry is a tremendous privilege and responsibility that we take very seriously. Listening to our customers' requirements and needs, we strive to make our solutions innovative, reliable, easy to use, and secure. We invest in our people, tools, and facilities in order to produce designs that exceed our customers' requirements. Engineering is our middle name, and it's what we love to do."

—Dave Whitehead
Chief Operating Officer

SERVICE AND SUPPORT YOU CAN COUNT ON

We understand the importance of local support, which is why we have application engineers, customer service representatives, and sales managers in over 100 offices worldwide. Our network of independent sales representatives and distributors provides additional sales support in many regions. This network of local experts supports SEL products and solutions in more than 164 countries, ensuring the best possible user experience.

SEL's outstanding customer service and support reflect who we are. Our commitment to serving our industry is consistent with our values and ethics. We believe strongly in our core company values, which are not only an essential part of our working environment but also the way we view our community, industry, and the natural environment.

"Society depends upon safe, reliable, and economical electric power. At SEL, we take our responsibility to this industry seriously. We strive to exceed expectations with extraordinary customer service, with expert application engineers who are always available to provide technical support close to our customers, and with sales engineers who solve problems by teaching and by adding value with SEL technology and innovation."

—David Costello
Senior Vice President of Sales and Customer Service

EXAMPLE PRODUCT APPLICATIONS

GENERATORS


Comprehensive Generator Protection
(SEL-300G, SEL-400G, SEL-700G)


Resistance Temperature Detection
(SEL-2600)


Ground Fault Protection
(SEL-2664, SEL-2664S)

DISTRIBUTED GENERATION (DG)


Intertie/Wind Generator Protection
(SEL-700GT, SEL-700GW)


Basic DG Protection
(SEL-547)


DG Interconnection Recloser Control
(SEL-651R, SEL-651RA)

TRANSMISSION LINES


Time-Domain Line Protection
(SEL-T400L, SEL-T401L)


Traveling-Wave Fault Location
(SEL-T400L, SEL-T401L, SEL-411L)


Subcycle Line Differential Protection
(SEL-311L, SEL-411L)


Subcycle Distance Protection
(SEL-421, SEL-311C)


Merging Unit With Built-In Distance Protection
(SEL-421)

POWER TRANSFORMERS


Five-Winding Transformer Differential
and Voltage Protection (SEL-487E)


Four-Winding Transformer Differential
Protection (SEL-387)


Three-Winding Transformer Differential
and Voltage Protection (SEL-387E)


Two-, Three-, and Four-Winding Transformer
Differential and Voltage Protection (SEL-787,
SEL-787-2/-3/-4)


Transformer Monitoring
(SEL-2414)

DISTRIBUTION FEEDERS


Distribution Protection
(SEL-351, SEL-351A, SEL-351S)


Protection, Automation, and Bay Control
(SEL-451)


Feeder Protection With Arc-Flash Detection
(SEL-751, SEL-751A)


Voltage Regulator Control
(SEL-2431)


Capacitor Bank Control
(SEL-734B)


Wireless Fault Detection
(SEL-FT50 and SEL-FR12)


Overhead and Underground Fault Indication
(AR360, AR-OH, AR-URD, TPR, CR)


Recloser Control (SEL-651R, SEL-651RA,
SEL-351RS Kestrel®)


Encrypted Wireless Communication
(SEL-3031, SEL-3061)


Compact Satellite-Synchronized Precise Time
(SEL-2401)


Real-Time Automation Control
(SEL-3505)


Wireless Fault Detection and Load Monitoring
(SEL-FLT and SEL-FLR, SEL-8301)

SUBSTATIONS


Satellite-Synchronized Precise Time (SEL-2401, SEL-2404, SEL-2407®, SEL-2488, SEL-3401)


Protection, Automation, and Bay Control (SEL-451)


Low-Impedance Bus Differential Protection (SEL-487B)


Capacitor Protection and Control (SEL-487V)


High-Impedance Differential Protection (SEL-587Z)


Power Quality and Revenue Metering (SEL-735)


Programmable Automation Control (SEL-2411, SEL-2440)


Annunciation and Notification (SEL-2522, SEL-2523, SEL-2533)


Merging Units With Built-In Protection (SEL-401, SEL-421)


Digital Secondary System Protection and Control (TiDL®, SEL-401, SEL-421, SEL-451, SEL-487B, SEL-487E)


Rugged Computing (SEL-3355, SEL-3360)


Wide-Area Communications (SEL ICON®)


Modular I/O and Real-Time Automation Control (SEL-2240 Axion®)


Real-Time Automation Control (SEL-3530/3530-4, SEL-3555, SEL-3505/3505-3, SEL-3560)


Cybersecurity (SEL-3620, SEL-3622)


Rugged Ethernet Networking (SEL-2730M, SEL-2730U, SEL-2725, SEL-2740S)


Encrypted Wireless Communication (SEL-3031, SEL-3061)


Bluetooth® Serial Communication (SEL-2924, SEL-2925)


High-Speed Remote I/O (SEL-2507)


Fiber-Optic Communication (Fiber-Optic Transceivers)

INDUSTRIAL/COMMERCIAL


Motor Protection (SEL-710, SEL-749M, SEL-849, MOTORMAX®)


Power Quality and Revenue Metering (SEL-735)


Annunciation and Notification (SEL-2522, SEL-2523, SEL-2533)


Programmable Automation Control (SEL-2411, SEL-2411P, SEL-2440)


Feeder Protection With Arc-Flash Detection (SEL-751, SEL-751A)

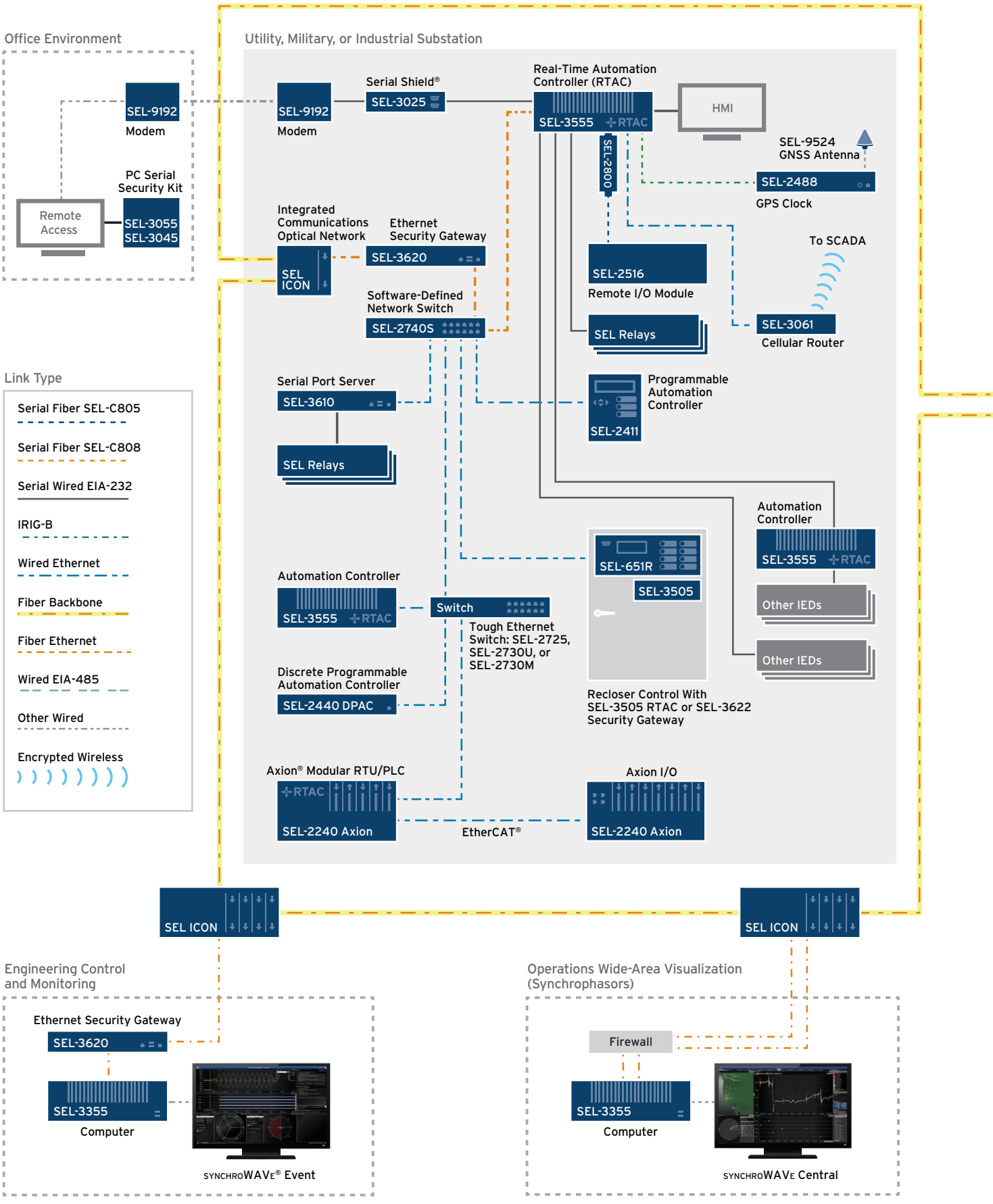

Rugged Ethernet Networking (SEL-2742S)

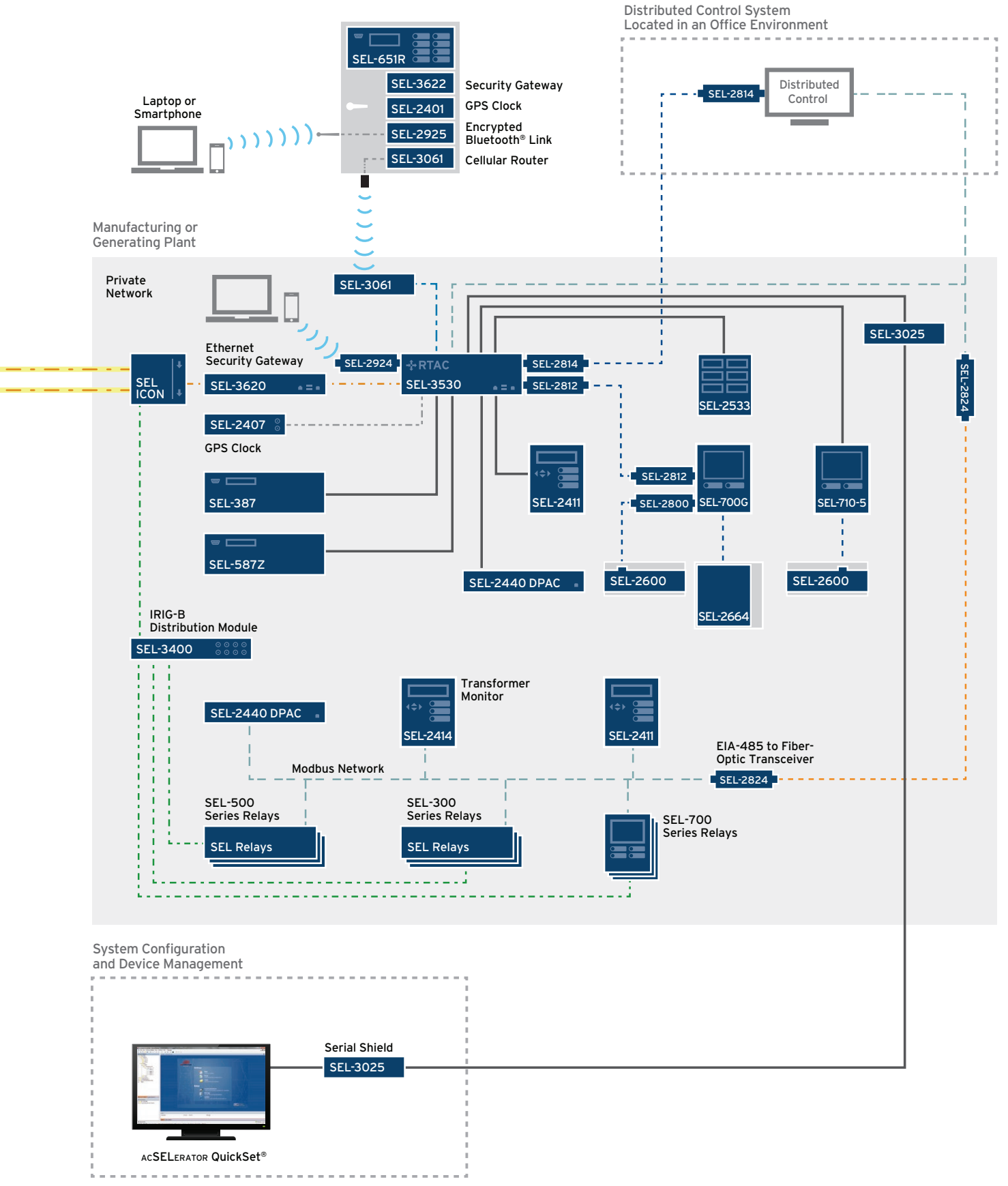

Fast Motor Bus Transfer (SEL-451)


Rugged Computing (SEL-3355, SEL-3360)


Modular I/O and Real-Time Automation Control (SEL-2240 Axion)

EXAMPLE NETWORK COMMUNICATIONS DIAGRAM




Distributed Control System
Located in an Office Environment
SEL-2814
Distributed Control
SEL-651R
SEL-3622
Security Gateway
SEL-2401
GPS Clock
SEL-2925
Encrypted Bluetooth® Link
SEL-3061
Cellular Router
Laptop or Smartphone
Manufacturing or Generating Plant
Private Network
SEL-3061
Ethernet Security Gateway
SEL-2924
SEL ICON
SEL-3620
RTAC
SEL-3530
SEL-2814
SEL-2812
SEL-3025
SEL-2824
SEL-2533
SEL-2407
GPS Clock
SEL-387
SEL-587Z
SEL-2411
SEL-2812
SEL-2800
SEL-700G
SEL-710-5
SEL-2440 DPAC
SEL-2600
SEL-2664
SEL-2600
IRIG-B Distribution Module
SEL-3400
SEL-2440 DPAC
Transformer Monitor
SEL-2414
SEL-2411
EIA-485 to Fiber-Optic Transceiver
SEL-2824
Modbus Network
SEL-500 Series Relays
SEL Relays
SEL-300 Series Relays
SEL Relays
SEL-700 Series Relays
System Configuration and Device Management
Serial Shield
SEL-3025
ACSELERATOR QuickSet®

GENERATOR AND MOTOR PROTECTION OVERVIEW

SEL-400G NEW

Provide unsurpassed protection, integration, control, and monitoring features for all types of generators, including hydropower, pumped-storage hydropower, large steam turbines, and combustion gas turbines.

SEL-700G

Provide utility and industrial generator protection with an autosynchronizer, flexible I/O, and advanced communications.

SEL-300G

Implement comprehensive primary and backup generator protection for large and small machines.

SEL-2664S

Protect high-impedance grounded generators from ground faults at stand-still, during startup, and while running.

SEL-2664

Combine the SEL-2664 with other SEL generator protection devices to continuously monitor field-to-ground resistance and protect critical components, including rotor and stator windings.

SEL-2600

Measure and transmit data from up to 12 resistance temperature detector (RTD) inputs and one contact input over a single fiber-optic link.

SEL-710-5

Provide protection, including optional arc-flash detection, for a full range of medium-voltage, three-phase induction, and synchronous motors.

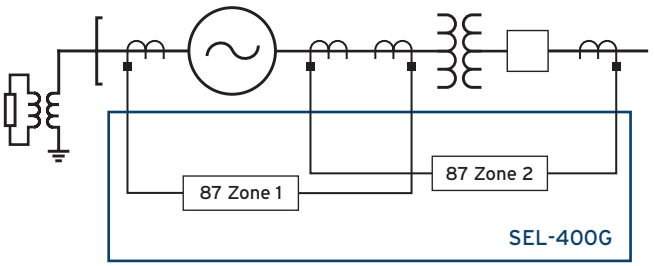
SEL-849

Provide current-, voltage-, and thermal-based protection; arc-flash detection; and power metering in motor protection applications.

	SEL-400G	SEL-700G	SEL-700GT	SEL-700GW	SEL-300G	SEL-710-5	SEL-849
APPLICATIONS							
Generator Protection	•	•	+		•		
Induction Motor Protection						•	•
Synchronous Motor Protection						+	
Feeder Protection				•			•
Breaker Failure Protection	•	•	•		ƒ	•	•
Equipment Thermal Monitoring	•	+	+	+	+	+	•
Generator Intertie Protection			•				
Synchronism Check	•	+	•		+		
Integrated Synchronizer	+	+	+				
PROTECTION							
21P Phase Mho or Compensator Distance	•	+			•		
24 Overexcitation (Volts/Hertz)	•	•	+		•		
27/59 Under-/Overvoltage	•	•	•		•	•	+
27I/59I Inverse-Time Under-/Overvoltage	•	•	•				
32 Directional Power	•	•	•		•	+	+
37 Underpower						+	+
40 Loss-of-Field	•	•	+		•	•	
46 Current Unbalance	•	•	+		•	•	•
47 Phase Reversal						•	•
49 Thermal	•	•	+			•	•
49R Thermal Overload (Resistance Temperature Detector [RTD])	•	•	•	•	•		
50 (P,N,Q) Overcurrent (Phase, Neutral, Negative Sequence)	•	•	•	•	•	•	•
50Q Negative-Sequence Overcurrent		•	•	•	•	•	•
51 (N,G) Time-Overcurrent (Neutral, Ground)	•	•	•	•	•	•	•
51 (P,Q) Time-Overcurrent (Phase, Negative Sequence)	•		•	•		•	•
55 Power Factor		ƒ	ƒ		ƒ	•	+
60 Loss-of-Potential	•	•	•		•	+	+
64G 100 Percent Stator Ground	•	+			•		
64F Field Ground	•	•	+		•		
67 (N,G) Directional Overcurrent (Neutral, Ground)		•	•				
78 Out-of-Step	•	•			•	•	
81 Over-/Underfrequency	•	•	•		•	•	+
87 Current Differential	•	+			+	+	
REF Restricted Earth Fault	•	•	+				
Arc-Flash Detection						+	•
Separate Neutral Overcurrent		•	+		•	•	•
Broken Rotor Bar Detection						+	
INSTRUMENTATION AND CONTROL							
Breaker Wear Monitor	•	•	•	•	•	•	
Demand Meter	•	•	•	•	•	•	•
Load Profile Report	•	•	•	•		•	•
RTD Inputs	•	+	+	+	+	+	
Ethernet	+	+	+	+		+	•
IEC 61850 Edition 2	+	+	+	+		+	+
IEC 60870-5-103		+	+	+		+	
Parallel Redundancy Protocol (PRP)	+	+	+	+		+	
DNP3 Serial	•	+	+	+	+	+	
DNP3 LAN/WAN	+	+	+	+		+	
Simple Network Time Protocol (SNTP)	+	+	+	+		+	•
Built-In Web Server	+	+	+	+		+	
IEEE 1588 Precision Time Protocol (PTP)	+	+	+	+		+	
Ethernet/IP		+	+	+		+	
Modbus TCP	+	+	+	+		+	+
Modbus RTU Outstation		•	•	•	+	•	•
Synchrophasors With IEEE C37.118 Protocol	•	•	•	•			
Mirrored Bits® Communications	•	•	•	•		•	

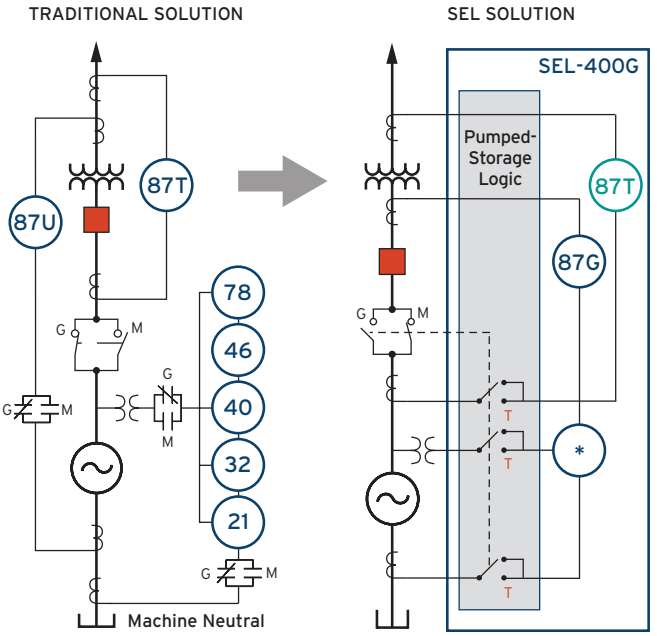
• Standard feature + Model option ƒ May be created using settings

GENERATOR AND MOTOR PROTECTION APPLICATIONS



DUAL DIFFERENTIAL ZONE PROTECTION NEW

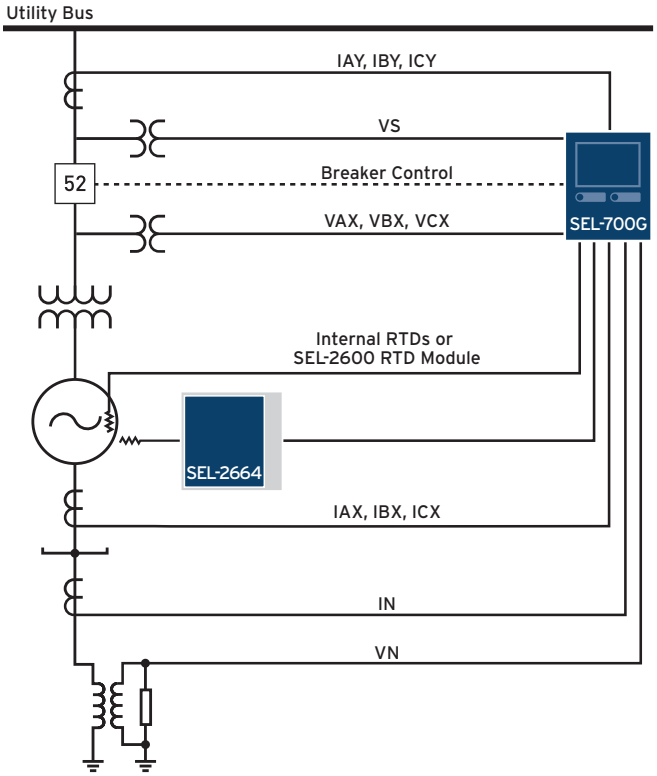
The SEL-400G Advanced Generator Protection System has two independent, universal differential elements, which provide protection for two independent protection zones. This allows separate generator and step-up transformer protection in a single device.



PUMPED-STORAGE HYDROPOWER PROTECTION NEW

Internal logic in the SEL-400G provides pumped-storage hydropower protection without additional equipment to compensate for the phase transposition between pumping and generating. The SEL-400G switches protection element phase currents and voltages at the correct times to ensure protection during pumping and generating. This eliminates the need for separate generation and motor protective relays or external relays to switch the CT/PT wiring, reducing complexity and expenses. Two separate differential zones, with independent frequency tracking and multiple sets of current inputs, eliminate the need to disable protective functions during starting and dynamic braking.

The SEL-400G handles the switching of all the protection elements and connections in the relay when operating in motor or generator mode. Traditionally, this required extensive external switching, which is prone to error. With two differential elements, the relay can also protect the transformer.



GENERATOR PROTECTION

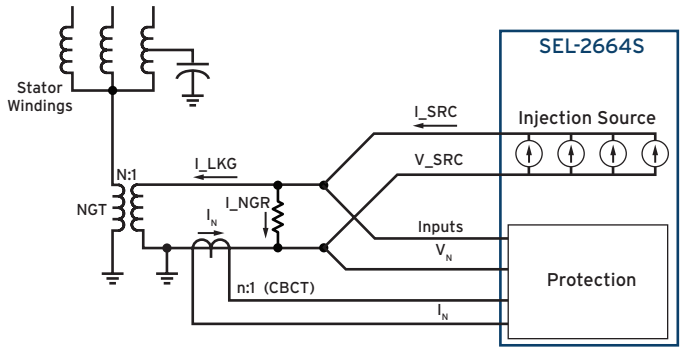
Numerous current, voltage, frequency, distance, power, and out-of-step elements in SEL generator protection relays provide comprehensive protection for large, medium, and small generators.

UNIT PROTECTION

Apply sensitive percentage-restrained current differential elements and an unrestrained element, along with synchronism-check and volts-per-hertz elements, to protect both the generator and the step-up transformer. Harmonic-blocking elements protect the unit transformer bushing and end windings while maintaining security for inrush and through-fault conditions.

STATOR/FIELD GROUND PROTECTION

With SEL generator relays, adding the neutral voltage connection provides 100 percent stator ground protection for most machines, based on third-harmonic voltage measurements. Connecting the neutral current input provides protection for solidly grounded or resistance-grounded machines. State-of-the-art voltage injection allows you to monitor field ground resistance.

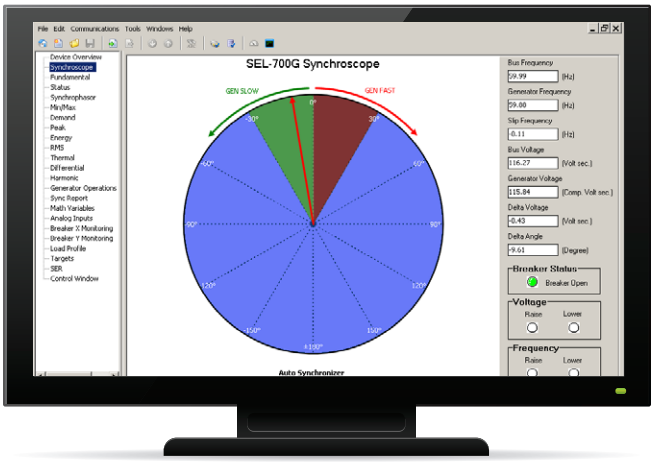


INJECTION-BASED STATOR GROUND PROTECTION

Frequency injection takes advantage of capacitive coupling between the stator winding and the ground. An injected signal passes through this higher impedance capacitive coupling to the ground. If a fault exists at any point in the stator winding, the injected signal will have a much lower impedance path to the ground. By monitoring the impedance to the ground using the injected signal, you can determine if a fault condition exists anywhere along the entire length of the winding. The SEL-2664S Stator Ground Protection Relay injects four frequencies to ensure that the machine is protected at all times, including during startup or overspeed conditions.

ADVANCED GENERATOR MONITORING AND REPORTING

With SEL software and generator relays, you can view autosynchronizer, Sequential Events Recorder (SER), and 180-cycle oscillographic event reports to analyze generator startup, shutdown, or system faults. You can also measure electrical, thermal, and generator run-time quantities. The breaker monitor function in the SEL-700G Generator Protection Relay lets you record accumulated breaker contact wear using manufacturer specifications for defining breaker operation limits. The relay's circuit breaker monitor tracks the total number of close/open operations and interrupted current to determine the percent of contact wear.

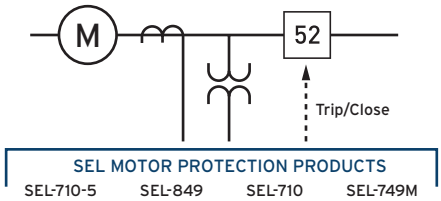


AUTOMATIC SYNCHRONIZATION

SEL synchronizing systems measure the voltage and frequency of generator and utility systems, sending correction pulses to adjust the governor and exciter as necessary and automatically close the breaker on synchronization. This process enables safe, secure, unattended synchronization of generation with the power system.

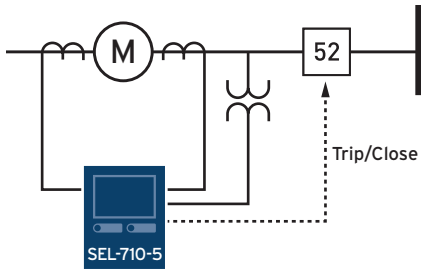
SYNCHRONIZED PHASOR MEASUREMENT

Combine the SEL-700G with an SEL IRIG-B time source to measure the system angle in real time with a timing accuracy of ±10 µs. You can measure instantaneous voltage and current phase angles in real time to improve system operation with synchrophasor information. With SEL-5078-2 SYNCHROWAVE® Central Software, you can view system angles at multiple locations for precise system analysis and system-state measurement.



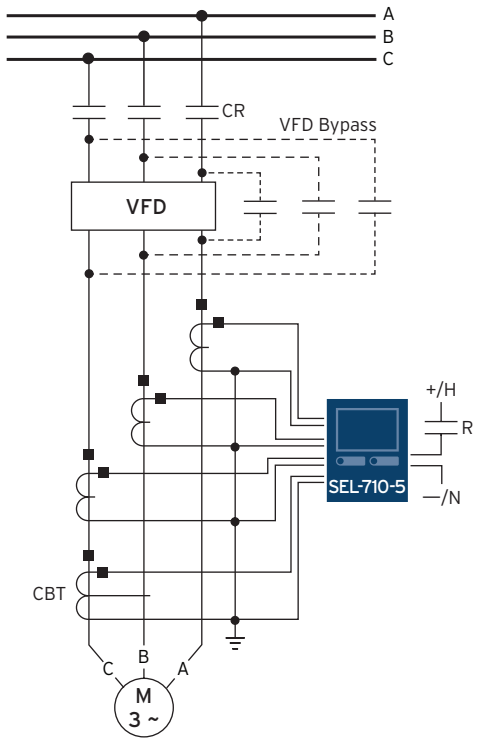
MOTOR PROTECTION

Protect a wide variety of low- and medium-voltage three-phase induction and synchronous motors using the SEL family of motor protection relays. Phase and neutral current elements feed accurate thermal models that track motor thermal characteristics during the stop/start/run cycles of the motor. One common application is a current-based protection scheme for across-the-line motor starting. Adding the voltage option to certain SEL motor relays enables the slip-dependent AccuTrack™ Thermal Model.



DIFFERENTIAL MOTOR PROTECTION

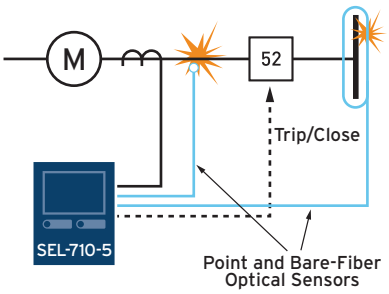
Use optional differential elements to protect the windings in high-value or critical-process motors.



VARIABLE-FREQUENCY DRIVE (VFD) MOTORS

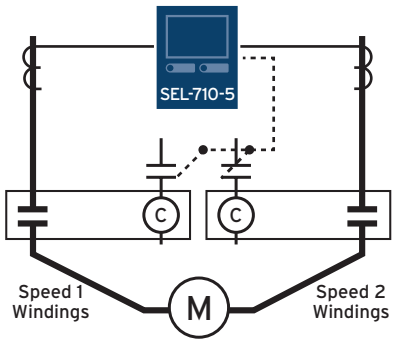
The SEL-710-5 Motor Protection Relay can protect VFD-fed motors, with an enhanced thermal model that tracks key motor characteristics during the stop/start/run cycles of the motor. VFDs are widely used to control the speed of ac motors for conveyor systems, blower speeds, electrical propulsion systems, and other applications that require variable speed.

When VFDs operate induction motors at low speeds, they may lack sufficient airflow to provide adequate cooling. The SEL-710-5 monitors this condition and dynamically compensates for the reduced cooling to provide thermal protection for the motor.



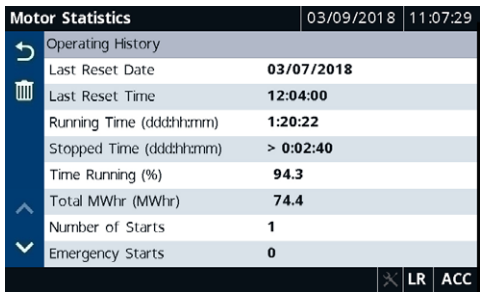
ARC-FLASH MITIGATION

Arc-flash mitigation improves worker safety by reducing the incident energy of the arc flash. Supervised by phase overcurrent elements, SEL relays with arc-flash detection provide secure and fast arc-flash mitigation. The fast response, in as little as 2–4 ms using high-speed, high-current interrupting output contacts, also reduces equipment damage and maintains process continuity.



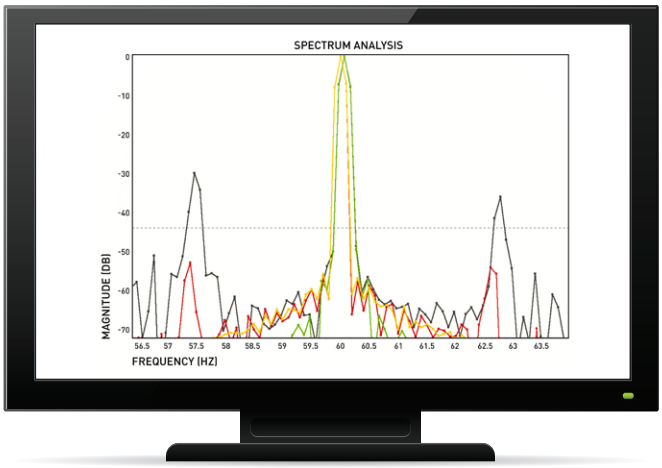
FLEXIBLE MOTOR STARTING

Take advantage of your SEL relay's ability to control multiple contactors, and apply motor protection in configurations for two-speed motors, full-voltage reversing, and star-delta (reduced-voltage) starting. This diagram shows interlocking contactors for a two-speed start.



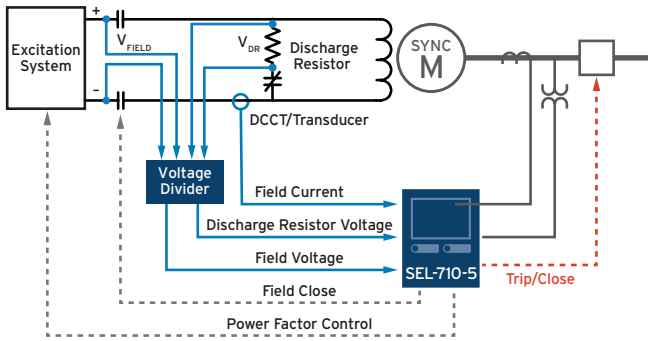
PREDICTIVE MONITORING

Unscheduled motor maintenance or unexpected failures can impact valuable processes. To help maximize asset life, the SEL-710-5 tracks key motor characteristics (vibration, motor start/stop times, and excessive wear on molded case circuit breakers) to identify problems before they occur. In addition, the incipient-fault detector can monitor the number of incipient faults to provide an early warning of cable failure. You can view this monitoring information from the available touchscreen display or in an easy-to-read report via the ASCII terminal.



BROKEN ROTOR BAR DETECTION AND SPECTRAL ANALYSIS

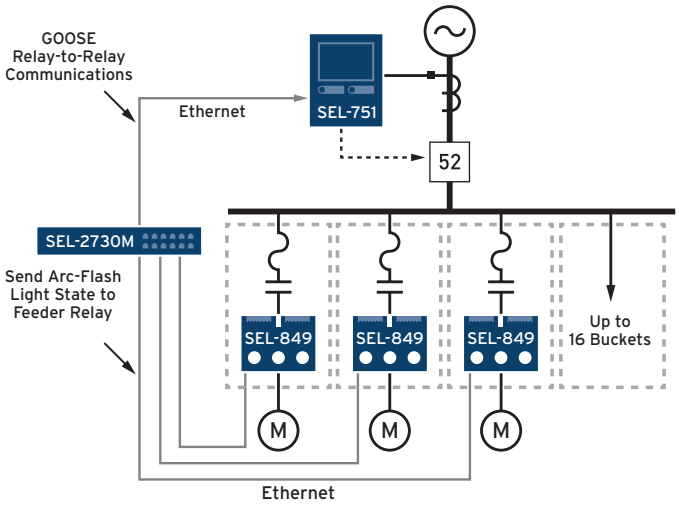
Broken rotor bar detection is an optional feature in the SEL-710-5. Fully loaded induction machines with broken rotor bars display unique frequency signatures as side-bands to the fundamental frequency. The magnitude of resulting side-band frequencies correlates to the number of broken rotor bars. The image shows a spectrum of a running motor with three broken rotor bars. The SEL-710-5 lets you catch rotor bar damage before it causes catastrophic damage to the motor.



SYNCHRONOUS MOTOR PROTECTION

Select the SEL-710-5 with the synchronous motor protection option to start and protect synchronous motors. With the SEL-710-5, you can monitor field voltage and current and effectively respond to loss-of-field, field resistance, out-of-step, power factor, and reactive power issues.

Shown here is a brush-type synchronous motor application where the field winding is connected to the relay through a voltage divider module.



CENTRALIZED MOTOR CONTROL

Create fully integrated motor control solutions with SEL motor relays, which include communications and protocol options that simplify device integration. This application shows SEL-849 Motor Management Relays in motor control center (MCC) buckets networked through an SEL-2730M Managed 24-Port Ethernet Switch. The relays share arc-flash detection data with the feeder relay using IEC 61850 GOOSE messaging.

For turnkey applications that require a smart integrated MCC, the SEL MOTORMAX® Low-Voltage Motor Management and Protection System combines motor protection, network management, and real-time automation control. MOTORMAX is a customizable motor management and control system that scales to fit any application. It delivers high-performance motor protection as well as high-speed reporting of motor status, alarms, and operating conditions at the HMI, allowing you to see the bigger picture.

SEL-400G NEW

ADVANCED GENERATOR PROTECTION SYSTEM

Starting Price
$10,000 USD

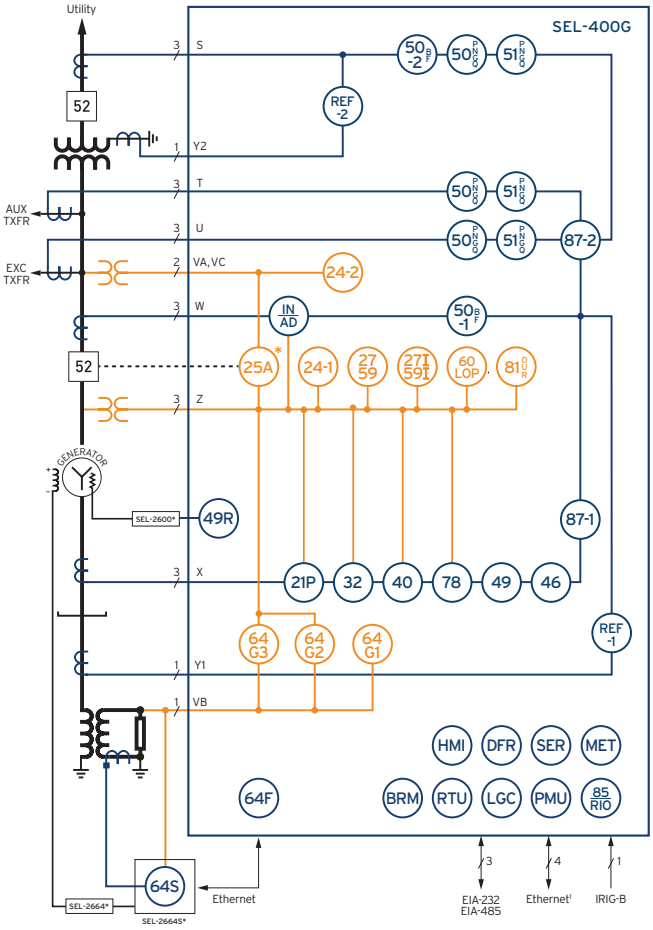
selinc.com/products/400G

The SEL-400G offers unsurpassed protection, integration, control, and monitoring features for all types of generators, including hydro, pumped-storage hydro, large steam turbines, and combustion gas turbines (CGTs). The relay combines generator, generator bus, and generator step-up (GSU) transformer protection in one package. The SEL-400G also includes SEL Grid Configurator to help you quickly and confidently create, manage, and deploy settings for SEL power system devices.

Numerous current and voltage inputs on the SEL-400G enable complex application support or protection of other equipment, such as transformers. It detects ground faults across 100 percent of the stator winding without sacrificing security and also detects stator winding turn-to-turn faults.

Two independent universal differential elements provide protection for two independent protection zones, which allows protection of both the generator and GSU transformer with a single SEL-400G.

The wide-range frequency tracking (5 to 120 Hz) enables protection during startup when frequencies are low because the generator is not spinning fast. In addition, pumped-storage logic enables pumped-storage hydro protection without the need for external relays to switch CT wiring, which lowers costs and improves reliability.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21P	Phase Distance
24	Volts/Hertz
25A	Automatic Synchronizer*
27/59	Under-/Overvoltage
27I/59I	Inverse-Time Undervoltage/Overvoltage
32	Directional Power
40	Loss-of-Field
46	Current Unbalance
49R	Thermal Overload (Resistance Temperature Detector [RTD])
49T	Thermal Overload (Thermal Model)
50SC	Shaft Current Monitor and Alarm
50BF	Breaker Failure
50 (P,N,G,Q)	Overcurrent (Phase, Neutral, Ground, Negative Sequence)
51 (P,N,G,Q)	Time-Overcurrent (Phase, Neutral, Ground, Negative Sequence)
60LOP	Loss-of-Potential
64 G1/G2/G3	100 Percent Stator Ground
64F	Field Ground
64S	Stator Ground (Harmonic Injection)
77	Field Device
78	Out-of-Step
81 (O,U,R)	Frequency (Over, Under, Rate)
87	Three-Phase Current Differential
87SF	Stator/Field Current Differential Element
AP	Aurora-Proof Output Contacts
IN AD	Inadvertent Energization
REF	Restricted Earth Fault

ADDITIONAL FUNCTIONS	
52PB	Pushbutton Trip/Close
85 RIO	SEL Mirrored Bits® Communications
BF	Breaker Failure
BRM	Breaker Wear Monitor
DFR	Event Reports
HMI	Operator Interface
LDP	Load Data Profiling
LGC	SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder (SER)
RTU	Remote Terminal Unit

*Optional feature

¹Copper or fiber-optic

EIA-232 front serial port is quick and convenient for system setup and local access.

Easy-to-use keypad aids simple navigation.

Front-panel, tricolor LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.

Front-panel display allows operators to control and view the status of disconnects and breakers.

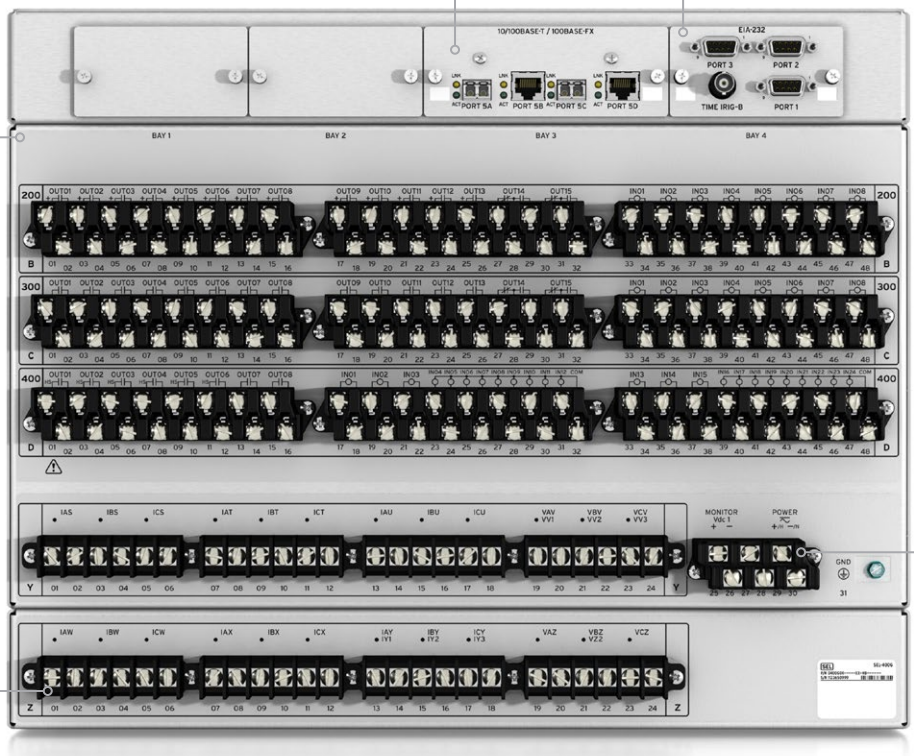
User-selectable mimic screens show the system configuration in one-line diagram format.

Programmable operator push-buttons with user-configurable labels allow front-panel customization.

Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.

Use one front and three rear EIA-232 ports for MIRRORED BITS communications, DNP3, SCADA, and engineering access.

Choose from a horizontal panel-mount or rack-mount chassis.



The 18 current and 6 voltage channels support differential protection for up to 6 three-phase terminals, 3 independent REF elements, and voltage elements.

Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.

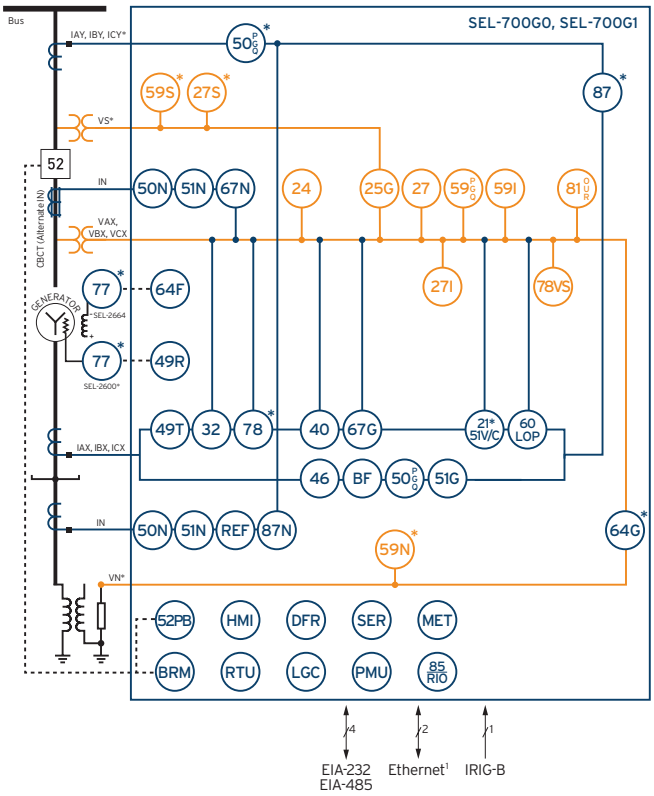
SEL-700G

GENERATOR PROTECTION RELAY

Starting Price
$2,500 USD

selinc.com/products/700G

The SEL-700G provides comprehensive primary and backup generator protection. With an autosynchronizer, flexible I/O, built-in web server, and advanced communications, it is the right solution for utility and industrial generator protection.



Model Comparison Table

You can customize the SEL-700G for specific applications by selecting preconfigured model options.

MODEL	APPLICATION
SEL-700G0 or SEL-700G0+	Basic generator protection
SEL-700G1 or SEL-700G1+	Full generator protection
SEL-700GT	Intertie protection
SEL-700GT+	Intertie and generator protection
SEL-700GW	Basic dual-feeder protection

ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21C/51VC	Compensator Distance, Voltage Restrained/Controlled Time-Overcurrent
24	Volts/Hertz
25G	Synchronism Check
27	Undervoltage
27I	Inverse-Time Undervoltage
27S	Synchronism Undervoltage
32	Directional Power
40	Loss-of-Field
46	Current Unbalance
49R	Thermal Overload (Resistance Temperature Detector [RTD])
49T	Thermal Model
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51 (P,G,Q)	Time-Overcurrent (Phase, Ground, Negative Sequence)
51N	Neutral Time Overcurrent
59I	Inverse-Time Overvoltage
59N (64G1)	Neutral Overvoltage
59S	Synchronism Overvoltage
59 (P,G,Q)	Overvoltage (Phase, Ground, Negative Sequence)
60	Loss-of-Potential
64F	Field Ground
64G	100% Stator Ground
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Negative Sequence)
67N	Directional Neutral Overcurrent
78	Out-of-Step
78VS	Vector Shift
81 (O,U,R)	Frequency (Over, Under, Rate)
87	Three-Phase Current Differential
87N	Neutral Current Differential
REF	Restricted Earth Fault

ADDITIONAL FUNCTIONS	
52PB	Pushbutton Trip/Close
85 RIO	SEL Mirrored Bits® Communications
BF	Breaker Failure
BRM	Breaker Wear Monitor
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LDP	Load Data Profiling
LGC	SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
RTU	Remote Terminal Unit
SER	Sequential Events Recorder

*Optional feature

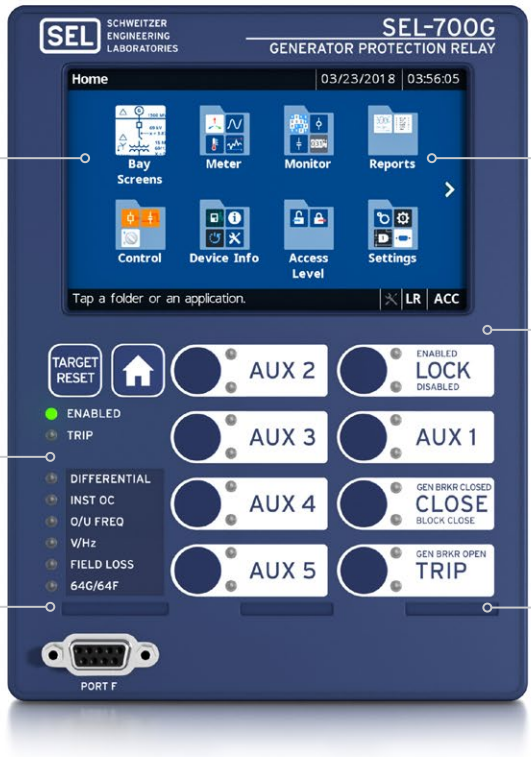
[1]Copper or fiber-optic

The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.

Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.

Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.

Programmable operator pushbuttons with user-configurable labels allow front-panel customization.



Power supply options include 24—48 Vdc, 110—250 Vdc, or 110—240 Vac.

Options for Ethernet, Modbus TCP, DNP3, Ethernet/IP, IEEE 1588 Precision Time Protocol (PTP), or IEC 61850 Edition 2 provide flexibility for communication with other devices and control systems.

Positions for optional expansion cards.

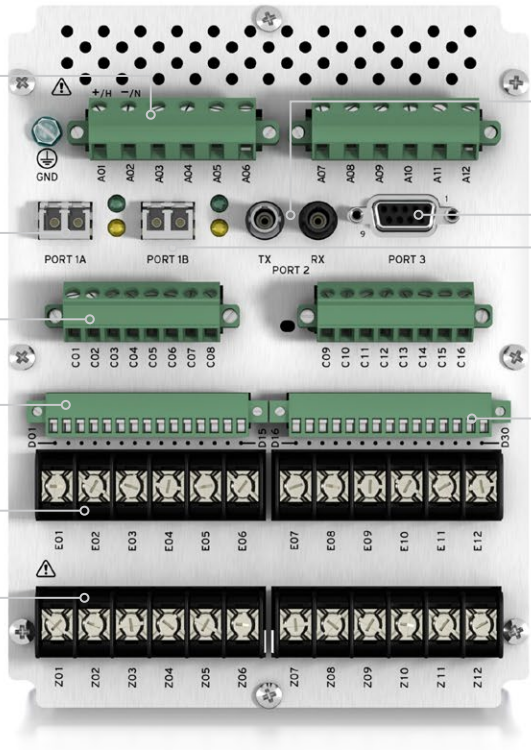
CT and PT inputs are located on one card, allowing for more I/O in other slots.

Port options include demodulated IRIG-B for precise-time input and EIA-232 or EIA-485 serial for fast integration into applications.

MIRRORED BITS communications provides fast and reliable relay-to-relay communication.

An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.

Optional RTD inputs.

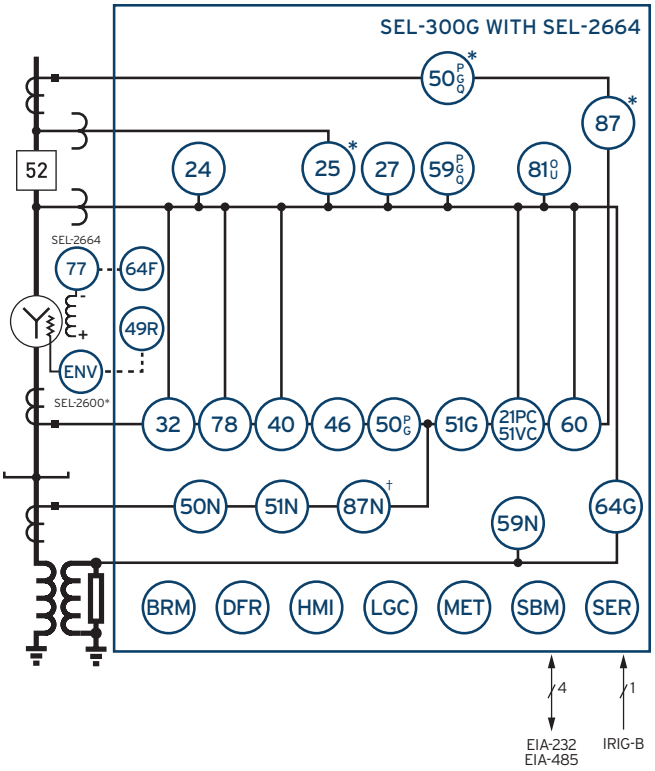


SEL-300G
GENERATOR RELAY

Starting Price
$3,100 USD

selinc.com/products/300G

The SEL-300G provides proven primary and backup protection for utility and industrial generators, meeting IEEE turbine protection standards. High-speed protection for all types of phase and ground faults limits equipment damage and speeds up repairs. Current and voltage elements protect large and small generators against faults, and optional differential protection provides sensitive and fast protection for generators and unit transformers. In addition, harmonic blocking improves security when transformers are in the generator differential zone. The SEL-300G provides 100 percent stator ground fault protection, using fundamental and third-harmonic voltage signals to protect high-impedance grounded generators. Adding the SEL-2664 Field Ground Module lets you detect field ground faults whether the generator is operating, stopped, or de-energized.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21PC/51VC	Phase Mho or Compensator Distance Voltage Restrained/Controlled Time-Overcurrent
24	Volts/Hertz
25	Synchronism Check*
27	Undervoltage
32	Directional Power
40	Loss-of-Field
46	Negative-Sequence Overcurrent
49R	Thermal Overload
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)*
51G	Ground Time Overcurrent
51N	Neutral Time Overcurrent
59N	Neutral Overvoltage
59 (P,G,Q)	Overvoltage (Phase, Ground, Negative Sequence)
60	Loss-of-Potential
64F	Field Ground
64G	100 Percent Stator Ground
78	Out-of-Step
81 (O,U)	Over-/Underfrequency
87	Three-Phase Current Differential*
87N	Neutral Current Differential†

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
SBM	Station Battery Monitor
SER	Sequential Events Recorder

*Optional feature

†Available in models that do not specify 87 element

SEL-2664S

STATOR GROUND PROTECTION RELAY

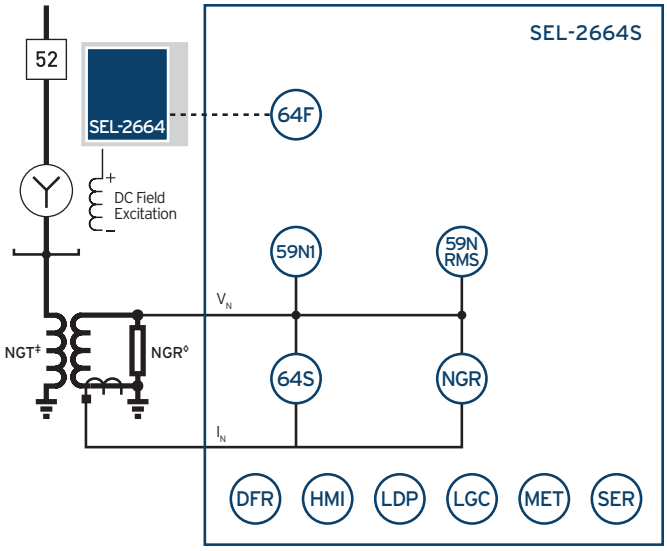
Starting Price

SEL-2664S: $9,000 USD

selinc.com/products/2664S

The SEL-2664S uses multisine frequency injection and neutral overvoltage-based protection to protect high-impedance grounded generators from ground faults at standstill, during startup, and while running. Up to four individual injected frequencies eliminate protection blind spots during generator startup.

Use the SEL-2664S as a standalone protection device or with the SEL-400G Advanced Generator Protection System, SEL-300G Generator Protection Relay, or SEL-700G Generator Protection Relay. For complete ground fault protection on both the rotor and stator, you can add the SEL-2664 Field Ground Module to the SEL-2664S.



‡Neutral grounding transformer
◊Neutral grounding resistor

ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
59N	Stall-Speed Switch
64F	Undervoltage*
64S	Undercurrent/Underpower*

ADDITIONAL FUNCTIONS	
DFR	Event Reports
HMI	Operator Interface
LDP	Profile Report Monitoring
LGC	SELOGIC® Control Equations
MET	Metering
NGR	Neutral Grounding Resistor Open/Short
SER	Sequential Events Recorder

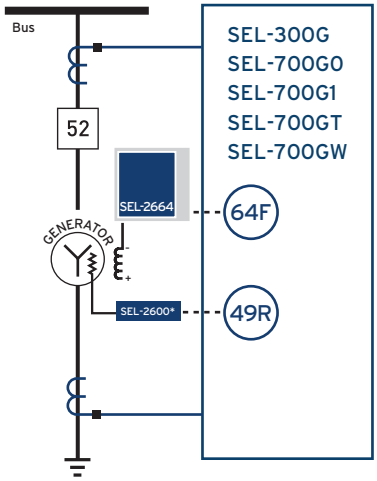
*Optional feature

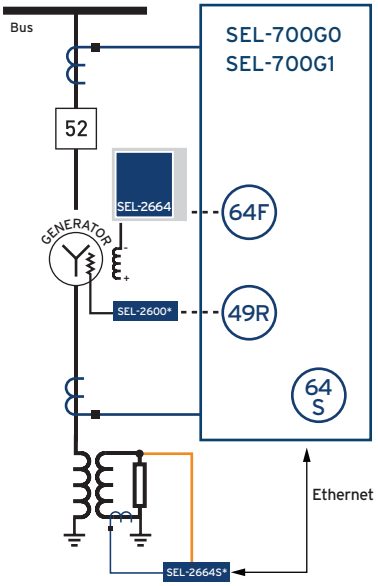
SEL-2664
FIELD GROUND MODULE

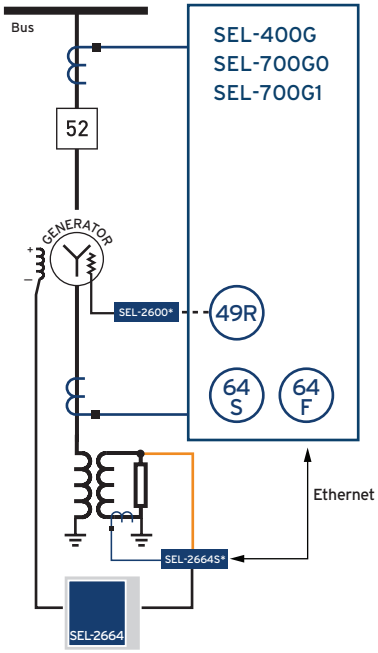
Starting Price
SEL-2664: $1,500 USD

selinc.com/products/2664

The SEL-2664 integrates with the SEL-300G Generator Relay or SEL-700G Generator Protection Relay to protect all the critical components in your generator. You can add the SEL-2664 to the SEL-2664S Stator Ground Protection Relay for complete ground fault protection on both the rotor and stator. Or, you can combine the SEL-2664, SEL-2664S, and SEL-400G Advanced Generator Protection System for an advanced solution.







ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
49R	Thermal Overload (Resistance Temperature Detector [RTD])
64F	Field Ground
64S	Stator Ground (Harmonic Injection)

*Optional feature

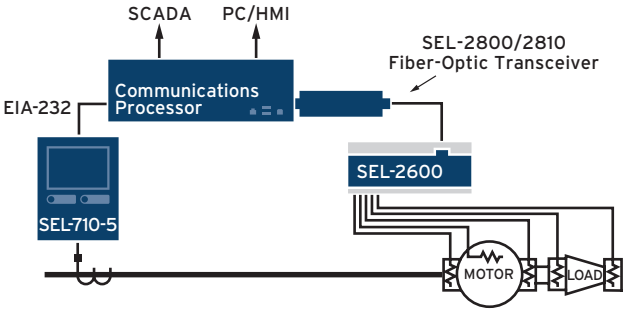
SEL-2600

RTD MODULE

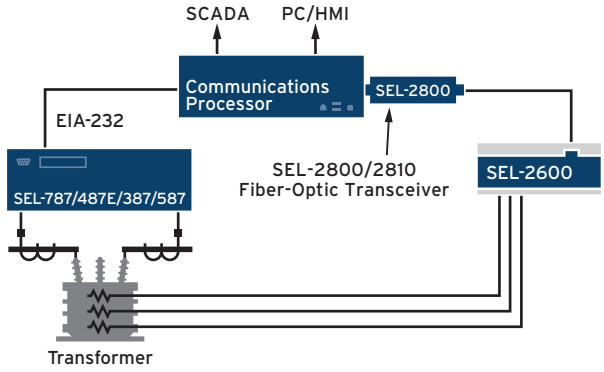
Starting Price
$790 USD

selinc.com/products/2600
Select models typically ship in 2 days

The SEL-2600 transmits data from up to 12 resistance temperature detector (RTD) inputs and a single contact input over a fiber-optic link. One module can accommodate multiple RTD types—copper, nickel, and platinum—to reduce equipment costs. With a flexible panel mount and inexpensive fiber-optic communications, you can place the rugged module near equipment to avoid costly cable installation.

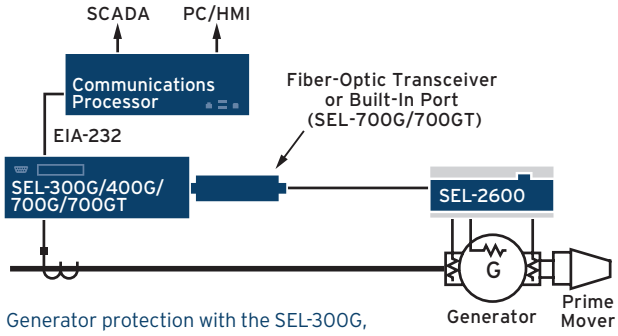


Motor protection with the SEL-710-5.



Transformer protection with the SEL-787, SEL-487E, SEL-387, or SEL-587.

(Note: SEL-387 and SEL-387A Relays accept direct SEL-2600 RTD Module connection using SEL-2800 or SEL-2812 Fiber-Optic Transceivers.)



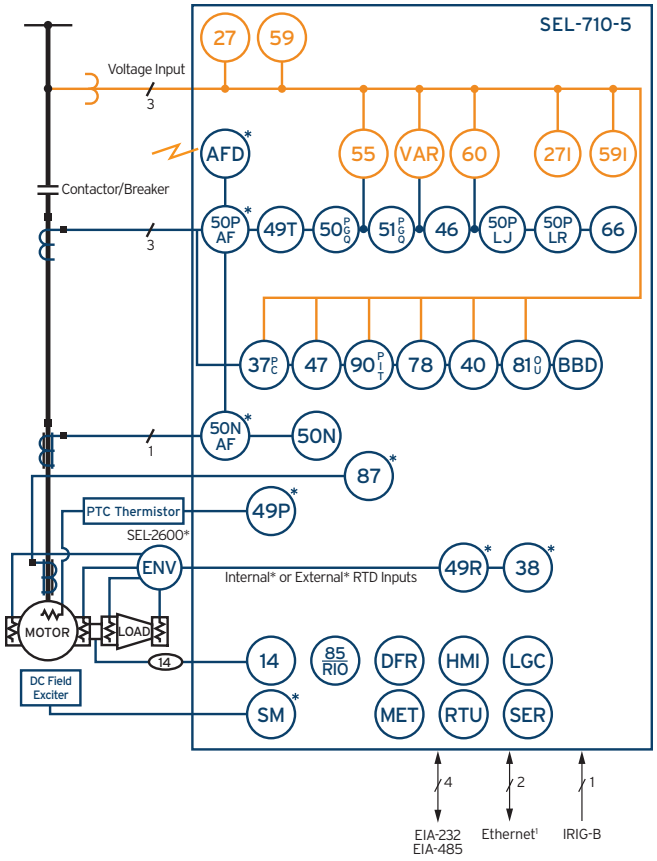
Generator protection with the SEL-300G, SEL-400G, SEL-700G, or SEL-700GT.

SEL-710-5
MOTOR PROTECTION RELAY

Starting Price
$3,000 USD

selinc.com/products/710-5

A single SEL-710-5 can protect asynchronous (induction) and synchronous motors. Features include broken rotor bar detection, incipient-fault detection, predictive-maintenance capability, and variable-frequency drive (VFD) support as well as options for arc-flash detection (AFD), differential protection, and synchronous motor protection. The synchronous option supports power factor regulation and includes, at no additional cost, a voltage divider accessory to interface with the motor excitation system. Together with the SEL AccuTrack™ Thermal Model, these features provide a solution for all your motor protection applications.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
14	Speed Switch
27	Phase Undervoltage
27I	Phase Undervoltage With Inverse Characteristic
37 (P,C)	Underpower/Undercurrent
38	Bearing Temperature*
40	Loss-of-Field
46	Current Unbalance
47	Phase Reversal
49P	PTC Overtemperature*
49R	Resistance Temperature Detector (RTD) Thermal*
49T	Thermal Model
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
50N AF	Arc-Flash Neutral Overcurrent*
50P AF	Arc-Flash Phase Overcurrent*
50P LR	Locked Rotor
50P LJ	Load Jam
50N	Neutral Overcurrent
51 (P,G,Q)	Time-Overcurrent (Phase, Residual, Negative Sequence)
55	Power Factor
59	Phase Overvoltage
59I	Overvoltage With Inverse Characteristic
60	Loss-of-Potential
66	Starts-Per-Hour
78	Out-of-Step
81 (O,U)	Over-/Underfrequency
87	Current Differential*
90 (P,I,T)	Load Control (Power, Current, Thermal Capacity)

ADDITIONAL FUNCTIONS	
50/51	Adaptive Overcurrent
85 RIO	SEL Mirrored Bits® Communications
AFD	Arc-Flash Detector[2]
BBD	Broken Rotor Bar Detection
DFR	Event Reports—Motor Starts, Motor Operating Statistics
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LDP	Load Data Profiling
LGC	SELogic® Control Equations
MET	High-Accuracy Metering
RTU	Remote Terminal Unit
SDTM	Slip-Dependent AccuTrack Thermal Model
SER	Sequential Events Recorder (SER)
SM	Synchronous Motor Control and Protection[2]
VAR	Reactive Power
VFD	Variable-Frequency Drive Support

*Optional feature [1]Copper or fiber-optic

[2]Mutually exclusive optional features

The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.

Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.

Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.

Programmable operator pushbuttons with user-configurable labels allow front-panel customization.

Power supply options include 24—48 Vdc, 110—250 Vdc, and 110—230 Vac.

Optional Ethernet, Modbus TCP, DNP3, Ethernet/IP, IEEE 1588 Precision Time Protocol (PTP), or IEC 61850 Edition 2 provides flexibility for communication with other devices and control systems.

Dual Modbus TCP session capability reduces the number of connections needed and improves port efficiency.

An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.

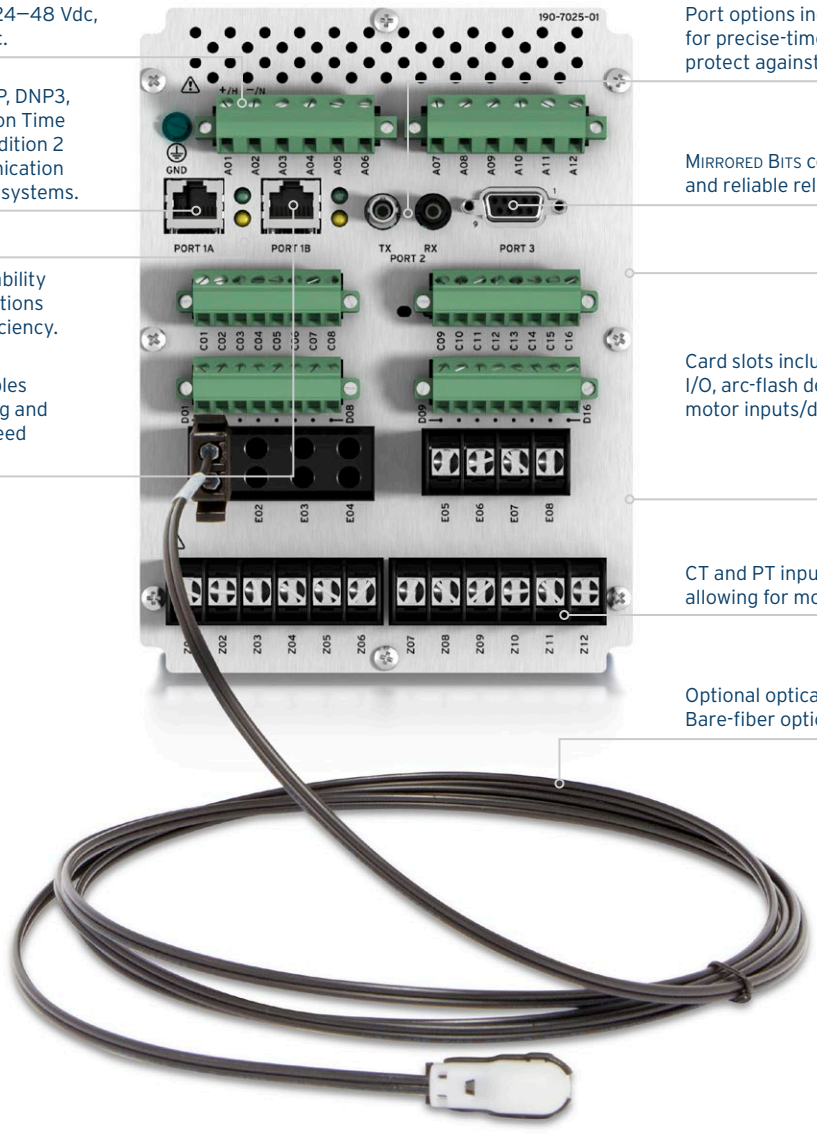
Port options include demodulated IRIG-B for precise-time input or a PTC input to protect against overcurrent conditions.

Mirrored Bits communications provides fast and reliable relay-to-relay communication.

Card slots include positions for optional I/O, arc-flash detection, or synchronous motor inputs/differential current inputs.

CT and PT inputs are located on one card, allowing for more I/O in other slots.

Optional optical point sensor for AFD. Bare-fiber optical sensors are also available.



SEL-849

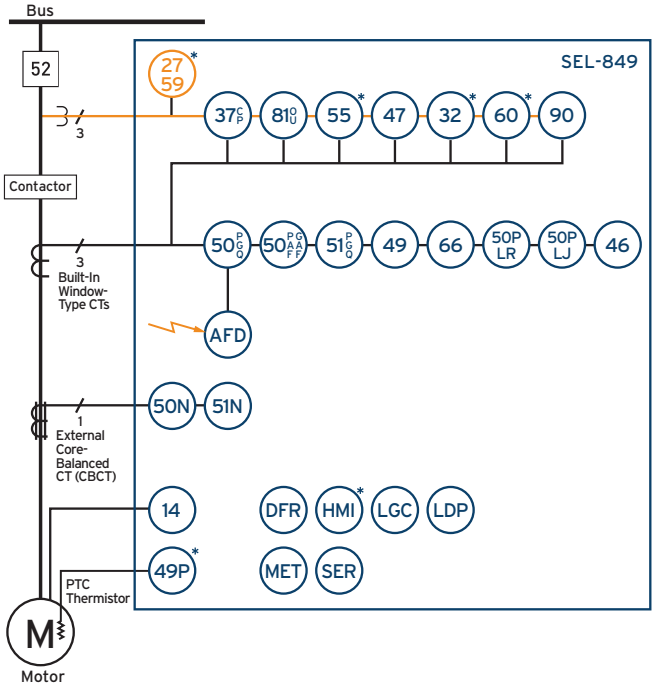
MOTOR MANAGEMENT RELAY

Starting Price
SEL-849: $699 USD
SEL-3421: $180 USD
SEL-3422: $120 USD

selinc.com/products/849

Select models typically ship in 2 days

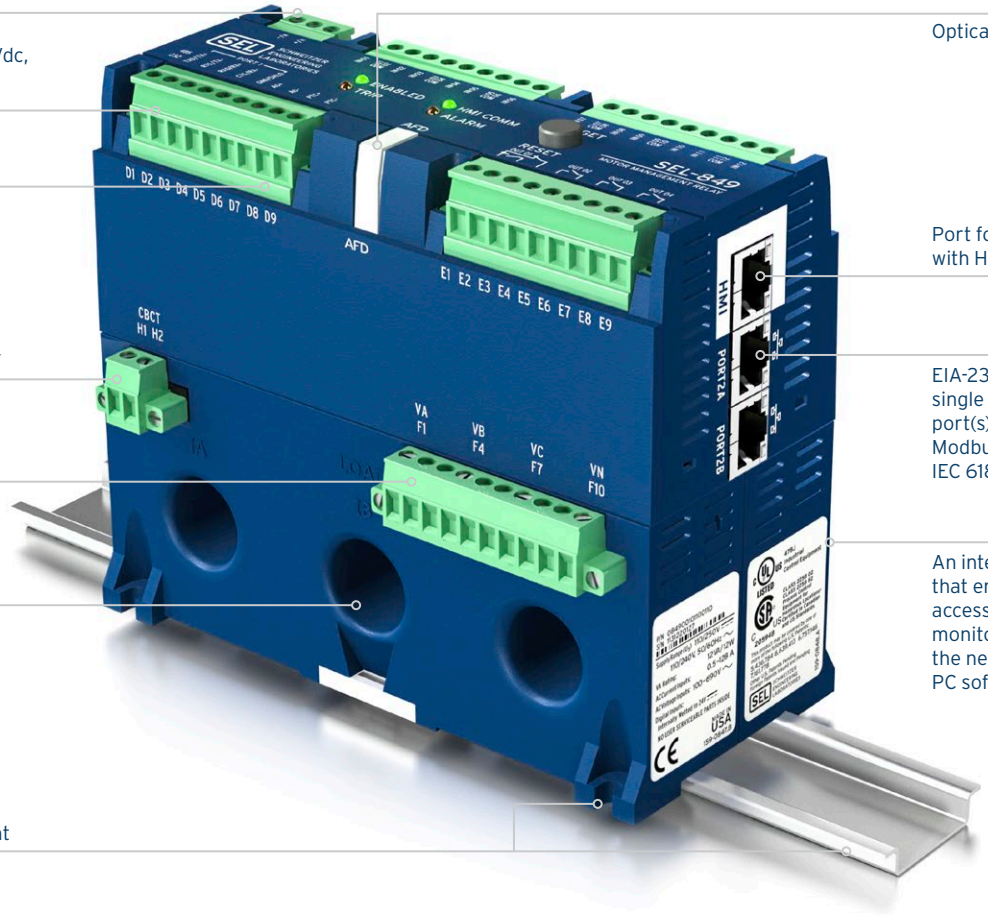
The SEL-849 offers current-, voltage-, and thermal-based motor protection; arc-flash detection; and power metering for low- and medium-voltage industrial applications. It provides all basic motor protection features, including protection for short-circuit, load loss, load jam, frequent starting, unbalanced current, and phase reversal conditions. You can easily install the SEL-849 inside a motor control center (MCC) and add the optional SEL-3421 and SEL-3422 Motor Relay HMIs to the front of the MCC.



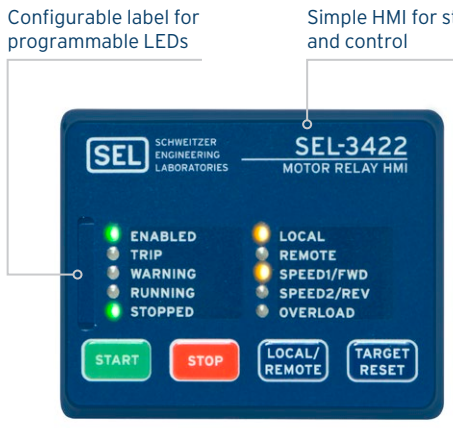
ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
14	Speed Switch
27	Undervoltage*
32	Directional Power*
37 (C,P)	Undercurrent, Underpower*
46	Current Unbalance
47	Phase Reversal
49	Thermal Model
49P	PTC Overtemperature*
50G AF	Arc-Flash Residual Overcurrent
50N	Neutral Overcurrent
50P AF	Arc-Flash Phase Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
50P LJ	Load Jam
50P LR	Locked-Rotor
51 (P,G,Q)	Time-Overcurrent (Phase, Residual, Negative Sequence)
51N	Neutral Time-Overcurrent
55	Power Factor*
59	Phase Overvoltage*
60	Loss-of-Potential*
66	Starts-Per-Hour
81 (O,U)	Over-/Underfrequency*
90	Load Control

ADDITIONAL FUNCTIONS	
AFD	Arc-Flash Detector
CC	Conformal Coating*
DFR	Event Reports—Motor Starts, Motor Operating Statistics, Sequential Events Recorder
HMI	Operator Interface*
LDP	Load Data Profiling
LGC	SELOGIC® Control Equations
MET	Metering—RMS Voltage and Current, Frequency, Power, Power Factor, Thermal, Thermal Capacity Used, Energy, Minimum/Maximum
SER	Sequential Events Recorder
VFD	Variable-Frequency Drive Support

*Optional feature



DETACHABLE DISPLAY MODULES (OPTIONAL)



TRANSMISSION PROTECTION OVERVIEW

SEL-T400L

Apply the SEL-T400L for ultra-high-speed protection of transmission lines. With breakthrough time-domain technologies, the SEL-T400L trips in as fast as 1 ms, records events with a 1 MHz sampling rate, and locates faults to the nearest tower.

SEL-T401L NEW

Apply the SEL-T401L, which was built on the field experience of the SEL-T400L, for its unprecedented operating speed and complete suite of primary and backup line protection functions. Use the SEL-T401L as a redundant protection system with other SEL relays without concerns for common-mode failures.

SEL-T4287

Test traveling-wave fault locators and line protective relays using the SEL-T4287, a simple-to-use, compact, and economical secondary pulse injection test set.

SEL-421

Employ the SEL-421 for high-speed distance and directional protection and complete control of a two-breaker bay.

SEL-411L

Apply the SEL-411L for subcycle single- or three-pole line current differential, distance, and directional overcurrent protection. Traveling-wave fault locating pinpoints faults to the nearest tower span.

SEL-311C

Apply the SEL-311C for three-pole distance protection, reclosing, monitoring, and control of transmission lines.

SEL-311L

Use the SEL-311L with four-zone distance backup for easy-to-apply, high-speed line protection.

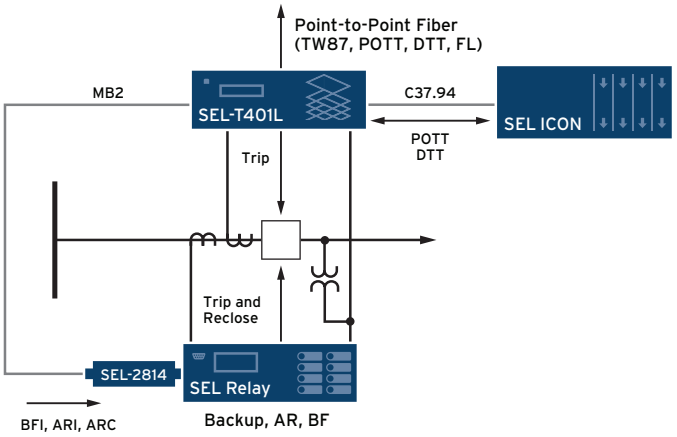
SEL-387L

Use the SEL-387L for economical, easy-to-apply line protection with zero settings.

	SEL-T400L	SEL-T401L	SEL-411L	SEL-421	SEL-311C	SEL-311L	SEL-387L
APPLICATIONS							
Distance Protection	•	•	•	•	•	•	
Line Current Differential			•			•	•
Traveling-Wave Protection	•	•					
Breaker Failure Protection			•	•	•	ƒ	
Undervoltage Load Shedding		ƒ	ƒ	ƒ	ƒ	ƒ	
Series-Compensated Lines	•	•	+	+			
PROTECTION							
21 (G,P,XG,XP) Distance (Mho Ground, Mho Phase, Quad Ground, Quad Phase)		•	•	•	•	•	
25 Synchronism Check			•	•	•	•	
27/59 Under-/Overvoltage		•	•	•	•	•	
32 Directional Power			•	•			
49 Thermal			ƒ	ƒ			
50 (N,G,P,Q) Overcurrent (Neutral, Ground, Phase, Negative Sequence)		•	•	•	•	•	
51 (N,G,P,Q) Time Overcurrent (Neutral, Ground, Phase, Negative Sequence)		•	•	•	•	•	
67 (N,G,P,Q) Directional Overcurrent (Neutral, Ground, Phase, Negative Sequence)		•	•	•	•	•	
81 Under-/Overfrequency			•	•	•	•	
87L Line Current Differential			•			•	•
Programmable Analog Math			•	•			
Out-of-Step Block and Trip		•	•	•	•	•	
Load-Encroachment Supervision		•	•	•	•	•	
Switch-Onto-Fault		•	•	•	•	•	
Single-Pole Trip	•	•	•	•	+	+	
TD21 Incremental-Quantity Distance	•	•					
TD32 Incremental-Quantity Directional	•	•					
TW32 Traveling-Wave Directional	•	•					
TW87 Traveling-Wave Differential	•	•					
Zone/Level Timers		•	•	•	•	•	
Pilot Protection Logic	•	•	•	•	•	•	
INSTRUMENTATION AND CONTROL							
79 Automatic Reclosing			•	•	•	•	
Number of Controlled Breakers/CT Inputs	2	2	2	2	1	1	1
Fault Locating	•	•	•	•	•	•	
Traveling-Wave Fault Locating	•	•	+				
Subcycle Distance Elements		•	+	+	+		
SELogic® Control Equations		•	•	•	•	•	
Nonvolatile Latch Control Switches		•	•	•	•	•	
SELogic Remote and Local Control Switches			•	•	•	•	
Display Points			•	•	+	•	
Mirrored Bits® Communications	•	•	•	•	•	•	
Substation Battery Monitor			•	•	•	•	•
Breaker Wear Monitor			•	•	•	•	
Trip Coil Monitor			ƒ	ƒ	ƒ	ƒ	
Event Report (Multicycle Data) and Sequential Events Recorder	•	•	•	•	•	•	•
1 MHz Event Reports	•	•					
Instantaneous Metering	•	•	•	•	•	•	•
Software-Invertible Polarities			•	•			
IEC 60255-Compliant Thermal Model			•	•			
DNP3 Level 2 Outstation	•	•	•	•	•	+	+
Parallel Redundancy Protocol (PRP)			•	•	•		
IEEE 1588 Precision Time Protocol Version 2 (PTPv2)			+	+			
IEEE C37.94 Protocol		•	+			+	
IEC 61850-9-2 Sampled Values Technology				+			
Time-Domain Link (TiDL®) Technology				+			
IEC 61850 Communications			+	+	+	+	
Synchrophasors			•	•	•	•	
Built-In Current and Voltage Playback Capability	•	•					
SEL Fast Time-Domain Values	•	•					
MISCELLANEOUS FEATURES							
Accepts Delta Voltage Transformers for Protection					+		
Configurable Labels	•	•	•	•	+		

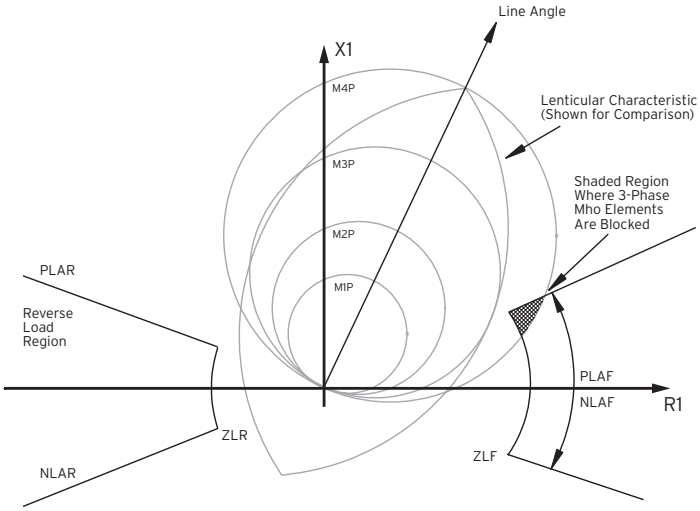
• Standard feature + Model option ƒ May be created using settings

TRANSMISSION PROTECTION APPLICATIONS



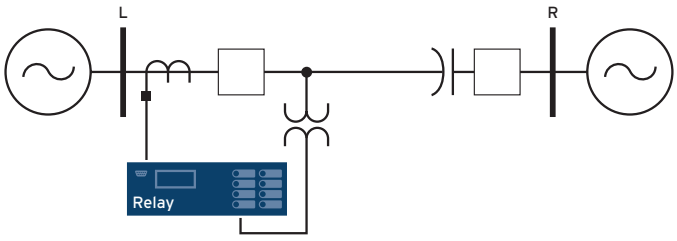
TIME-DOMAIN LINE PROTECTION

The SEL-T400L Time-Domain Line Protection and SEL-T401L Ultra-High-Speed Line Relay are designed for speed, security, and ease of use. They are the only relays that trip in as fast as 1 ms without compromising security. You can apply the SEL-T401L on its own or as part of a redundant protection system with other SEL relays without concerns for common-mode failures.



OPTIMIZED SYSTEM LOADING

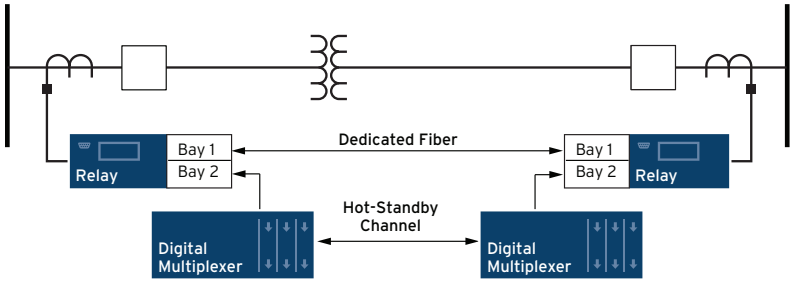
Set the phase distance and phase overcurrent elements independent of load to prevent load from causing the phase protection to operate. Under heavy load conditions, the measured impedance may fall inside the operating characteristic of a traditional phase distance element and cause an undesired operation. Traditional solutions involved reducing mho element reach or using a lenticular characteristic to prevent load encroachment. With built-in load-encroachment logic, two load regions are defined on the impedance plane and the relay rejects a minimum portion of the mho element characteristic, as shown. This allows you to securely apply distance protection elements on heavily loaded transmission lines.



SERIES-COMPENSATED LINES

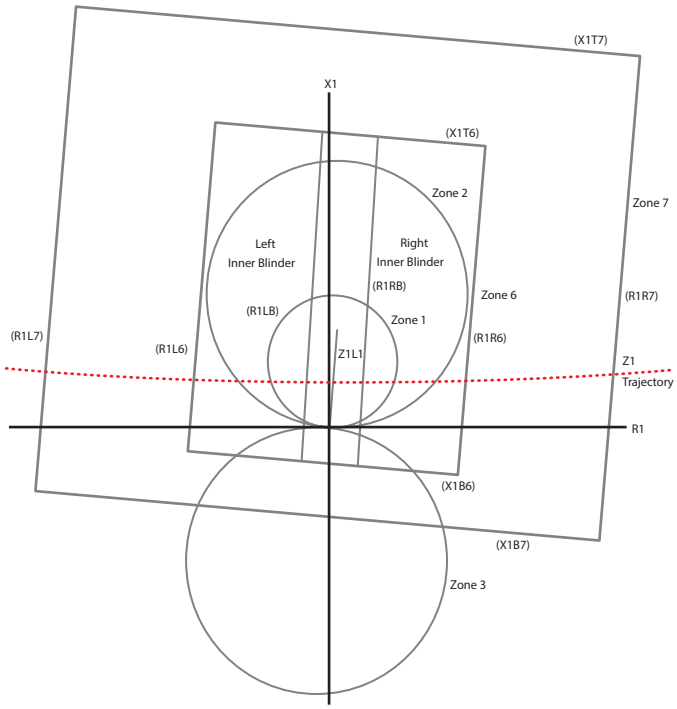
Detect faults beyond a series capacitor and prevent Zone 1 overreach on series-compensated lines with optional logic in the SEL-T400L; SEL-T401L; SEL-421-5 Protection, Automation, and Control System; and SEL-411L-1 Advanced Line Differential Protection, Automation, and Control System. Series compensation increases the power transfer capability of transmission lines and improves power system stability. However, when faults occur on series-compensated lines, the resulting voltage inversion or current reversal may cause traditional line protection to misoperate.

It's also important to enable this logic in parallel line applications where there is a series capacitor on the adjacent line. Series compensation logic achieves the desired sensitivity on the protected line, yet it is still secure during the voltage inversion that may occur when the neighboring series-compensated line experiences a fault.



IN-LINE TRANSFORMERS

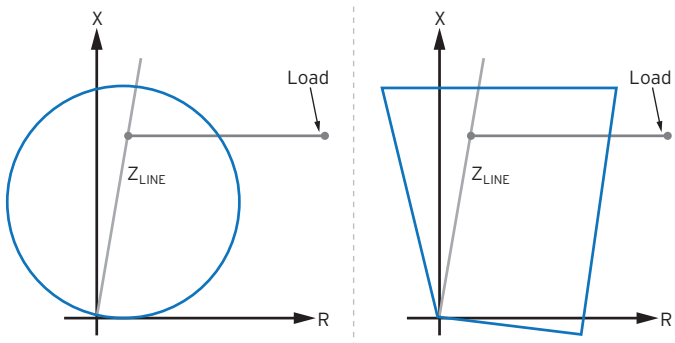
Use negative-sequence overcurrent elements in distance protection relays to protect transmission lines with in-line transformers. In differential relays, such as the SEL-411L, the Alpha Plane operating principle provides for true differential harmonic measurements and allows harmonic blocking, harmonic restraint, or both for security during the magnetizing inrush condition. Additionally, built-in settings allow the relay to perform proper vector group compensation, zero-sequence current balancing, and ratio matching per the principles of transformer differential protection.



IMPROVED SYSTEM STABILITY

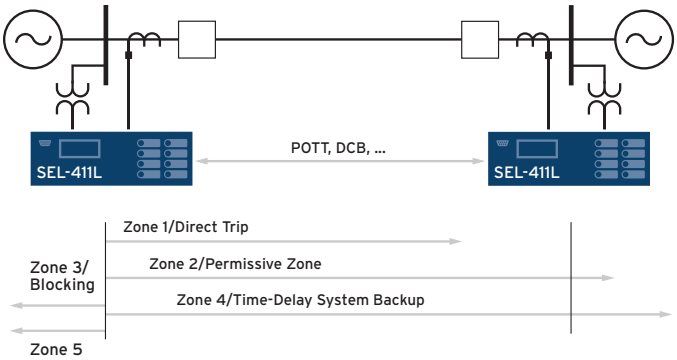
Select from either out-of-step (OOS) blocking of distance elements or OOS tripping during power swings. SEL transmission relays include multizone elements and logic for detection of an out-of-step condition.

The power-swing detection function differentiates faults from power swings and blocks distance or other relay elements from operating during stable or unstable power swings. The SEL-421 and SEL-411L come with a zero-setting OOS blocking function that is based on a swing-center voltage slope detector, OOS blocking detector, and three-phase fault detector. The zero-setting OOS function improves security during power swings without time-consuming and expensive system stability studies.



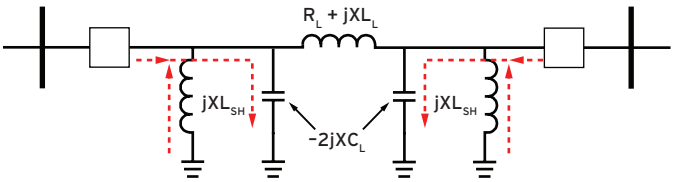
MHO AND QUADRILATERAL DISTANCE ELEMENTS

Select mho distance elements, quadrilateral distance elements, or both with SEL transmission relays. Some utilities prefer the mho distance elements because they are easy to set. However, other utilities favor the quadrilateral distance elements because they offer better resistive coverage. Quadrilateral elements provide the best protection for short lines where the impedance of the transmission line is the same magnitude as the fault resistance.



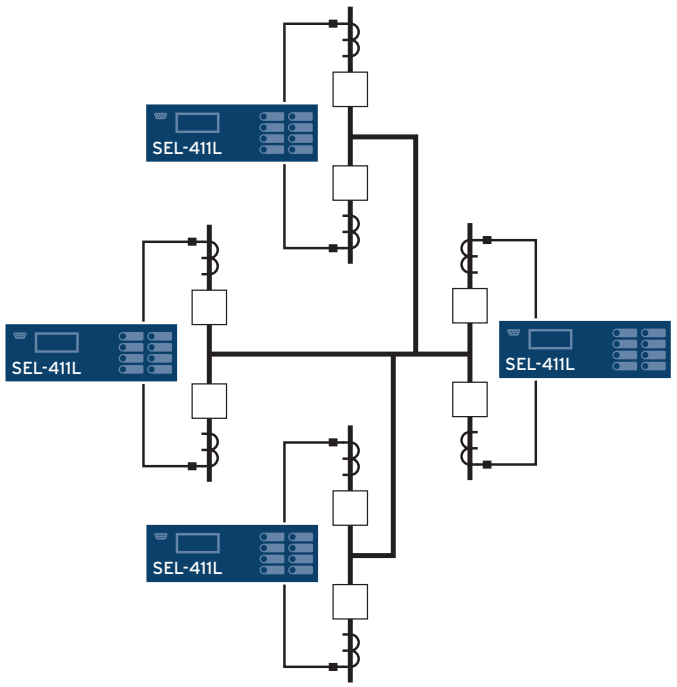
COMMUNICATIONS-ASSISTED TRIPPING

Configure protection for transmission lines without any need for external coordination devices. SEL transmission protection relays offer settings to accommodate many of the common pilot protection schemes, including permissive overreaching transfer trip (POTT), directional comparison unblocking (DCUB), and directional comparison blocking (DCB). These schemes work in both two- and three-terminal line applications.



LONG TRANSMISSION LINES

Enable line-charging current compensation in the SEL-411L for enhanced sensitivity and security for long extra-high-voltage lines or cables. The charging current compensation is based on voltage signals and includes a built-in fallback response if the voltage source suffers loss-of-potential conditions or becomes unavailable. The function performs compensation on a per-phase basis and in the time domain. Therefore, the charging current compensation is accurate under balanced and unbalanced conditions and for line pickup with uneven breaker pole operation, internal faults, and external faults.

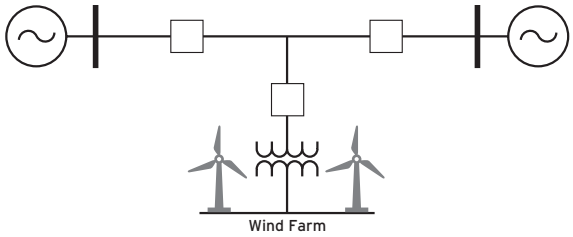


DIFFERENTIAL PROTECTION OF FOUR-TERMINAL AND PARALLEL TRANSMISSION LINES

Perform line current differential protection on lines with up to four terminals by using the 87L-over-Ethernet feature in the SEL-411L. You can use the SEL ICON® multiplexer to interconnect the SEL-411L Relays making up the differential zone. The SEL ICON ensures a dedicated LAN with the proper bandwidth and minimal latency needed for secure and reliable 87L-over-Ethernet communications.

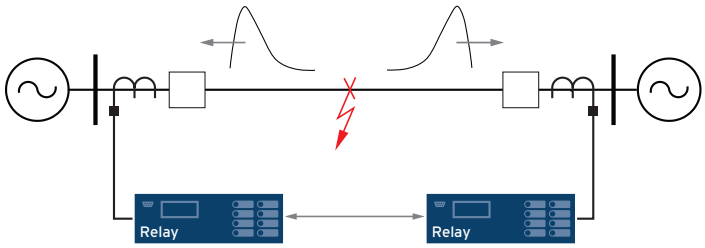
Protect up to three terminals with serial connections with the 87L scheme either in the master mode or master-outstation mode. In the master mode, all the relays act as master units, receive all the differential data, and trip directly on the data. In the case of a missing channel, you can use the relays in the master-outstation mode, where a single master unit receives all the data and sends a direct transfer trip to the slave units through a trip bit in the 87L channel. If the relays are in the master mode and a channel is suddenly lost, the scheme will automatically switch into the master-outstation mode to maintain 87L protection.

In parallel lines, the main issue is mutual coupling. Line current differential is immune to mutual coupling and is therefore very sensitive and secure in parallel-line applications.



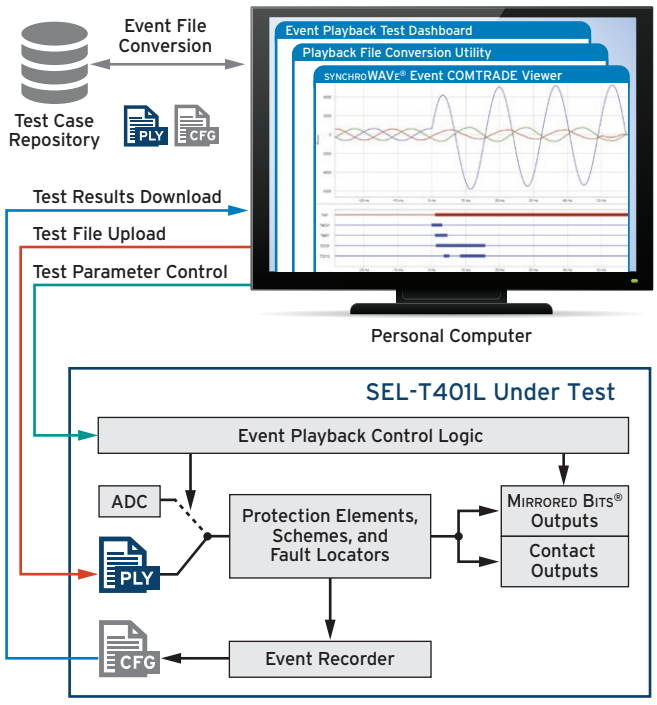
WEAK SYSTEMS AND INVERTER-BASED SOURCES

Choose a line current differential scheme for primary line protection when connecting wind farms to the utility grid. Fault current contributed from weak sources, such as doubly fed induction generators (DFIGs) in a wind farm, is just a fraction of the load current. This challenges any current-based distance or overcurrent protection method and requires weak infeed logic to properly protect the line. Line current differential schemes work best because the grid provides enough fault current to drive the differential signal up, while the inverter-based source doesn't create restraining.



TRAVELING-WAVE FAULT LOCATING

With advanced microprocessor-based relays, you can compute fault locations using four different methods: single-ended impedance-based, multi-ended impedance-based, single-ended traveling-wave fault locating (available in the SEL-T400L and SEL-T401L), and double-ended traveling-wave fault locating (available in the SEL-411L, SEL-T400L, and SEL-T401L). Based on input data availability, the relay selects one method of fault locating to provide in a summary report. Traveling-wave fault-locating methods accurately locate faults to within one tower span, allowing you to quickly send crews out to address the problem.



TESTING MADE EASY

The built-in current and voltage playback feature in the SEL-T400L and SEL-T401L provides you with new opportunities for relay testing. To test either relay, upload and play back either files generated using transient simulation software or current and voltage signals recorded by the SEL-T400L, the SEL-T401L, SEL-400 series relays, or digital fault recorders in the field.

Secondary injection testing of SEL-T400L and SEL-T401L I/O, metering, and protection elements (except TW32 and TW87) is straightforward. Today's relay test sets provide adequate signals to test incremental-quantity protection elements. Use the SEL-T4287 Traveling-Wave Test System to perform secondary injection testing of the TW32 and TW87 protection and the traveling-wave fault-locating methods.

SEL-T400L

TIME-DOMAIN LINE PROTECTION

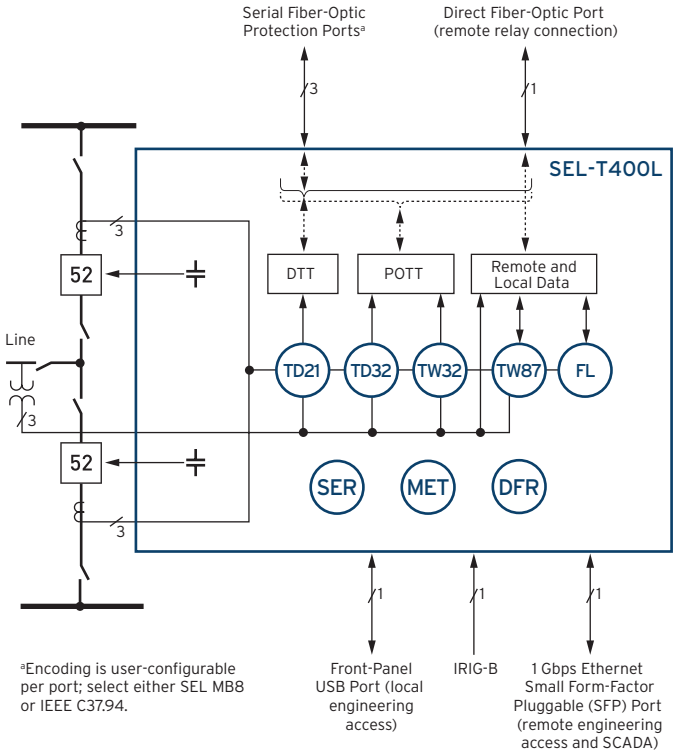
Starting Price

$12,000 USD

selinc.com/products/T400L

Select models typically ship in 2 days

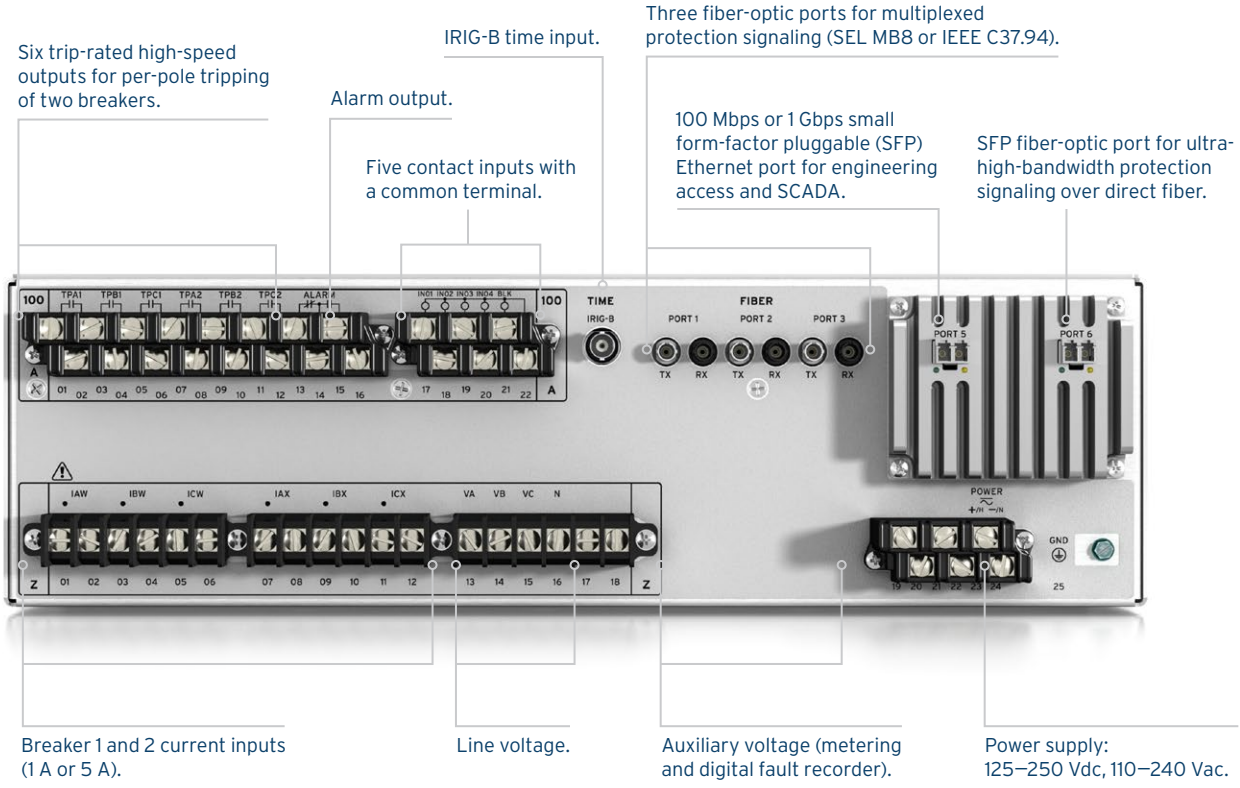
The SEL-T400L provides ultra-high-speed protection of transmission lines. With breakthrough time-domain technologies, the SEL-T400L trips securely in as fast as 1 ms, records events with a 1 MHz sampling rate, and locates faults to the nearest tower. Adding the SEL-T400L to your line protection system can dramatically reduce your fault-clearing time and let you achieve the many benefits associated with speed.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
1	Arming and Starting Logic
TD21	Incremental-Quantity Distance
TD32	Incremental-Quantity Directional
TW32	Traveling-Wave Directional
TW87	Traveling-Wave Differential
TD50	Incremental-Quantity Nondirectional Overcurrent Supervision
TD67	Incremental-Quantity Directional Overcurrent Supervision
DTT	Direct Transfer Trip Logic
POTT	Permissive Overreaching Transfer Trip Logic
94	High-Speed Trip-Rated Outputs
85 RIO	SEL Mirrored Bits® Communications
LOP	Loss-of-Potential Logic
TWDD	Traveling-Wave Disturbance Detection
DFR	1 MHz Event Recorder
SER	Sequential Events Recorder
FL	Fault Locator (with traveling-wave and impedance methods, single-ended and double-ended)
MET	Metering
HMI	Operator Interface

ADDITIONAL FUNCTIONS
Preconfigured Trip Logic
Single-Pole Tripping Logic
Open-Pole Detection Logic
Adaptive Autoreclose Cancel Logic
Traveling-Wave Test Mode
Event Playback
Front-Panel USB 2.0 Port for Engineering Access
Ethernet Port for Engineering and SCADA Access
Multilevel Passwords for Secure Access
Electromagnetic Interference Monitoring
Enhanced Self-Monitoring
Fast Time-Domain Values (FTDV)

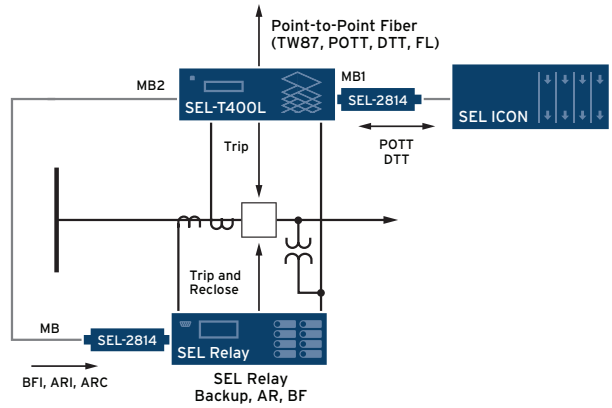
SEL-T400L OVERVIEW



POWERFUL APPLICATIONS

The SEL-T400L is an easy-to-use ultra-high-speed and secure transmission line protective relay. It provides protection of two-terminal and multiterminal lines with in-line and adjacent series compensation, in three-pole and single-pole tripping applications, for single- or dual-breaker line terminations.

The SEL-T400L also provides key line protection elements and schemes. For auxiliary functions, such as reclosing, synchronism check, breaker failure, communications protocols, and backup protection, you can use a companion relay, such as an SEL-421 Protection, Automation, and Control System or an SEL-411L Advanced Line Differential Protection, Automation, and Control System.



Recommended application of the SEL-T400L.

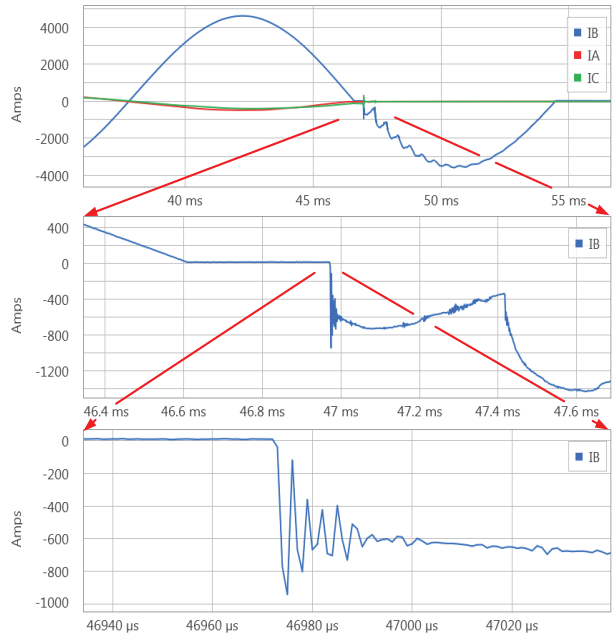
ULTRA-HIGH-SPEED LINE PROTECTION WITH SECURITY

The SEL-T400L features a traveling-wave differential scheme (TW87) over a dedicated point-to-point fiber channel; an incremental-quantity distance element (TD21); and a POTT scheme with traveling-wave (TW32) and incremental-quantity (TD32) directional elements over a digital or analog protection channel. You can achieve 1—5 ms trip times, depending on the channel, line length, and system conditions.

HIGH-RESOLUTION OSCILLOGRAPHY

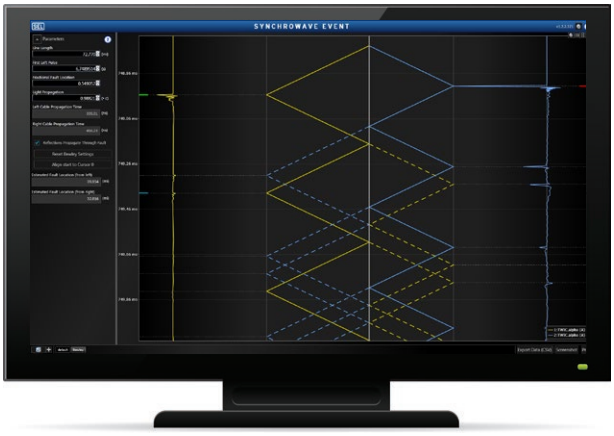
Using the SEL-T400L is like applying an oscilloscope to the power system. Now you can look at currents and voltages through a 1 MHz lens. The SEL-T400L stores as many as 50 events with a back-to-back recording capability and a duration of 1.2 seconds per event. The SEL-T400L also provides a COMTRADE file that contains currents and voltages sampled at 10 kHz, selected operating quantities, Relay Word bits, settings, and fault location and event summary data.

When using a direct fiber-optic channel, the local 1 MHz and 10 kHz records also contain remote voltages and line currents.



UNPARALLELED FAULT-LOCATING ACCURACY

The SEL-T400L provides you with state-of-the-art fault-locating technology. A simple and robust double-ended traveling-wave fault-locating method gives you a very accurate fault location in the vast majority of cases. The method works over a multiplexed IEEE C37.94 channel with accurate external IRIG-B-connected time sources at both line terminals and over a direct fiber channel (external time not required). The method works well on overhead lines, underground cable lines, and hybrid lines composed of both overhead and underground cable sections. Benefit from the single-ended traveling-wave fault-locating method in applications without relay-to-relay communications or when your digital protection channel is down. Obtain good fault-locating results from the backup double- and single-ended impedance-based fault-locating methods when the point on wave or termination effects prevent the traveling-wave methods from locating the fault.



Visualize traveling-wave event reports using SEL-5601-2 SYNCHROWAVE Event Software.

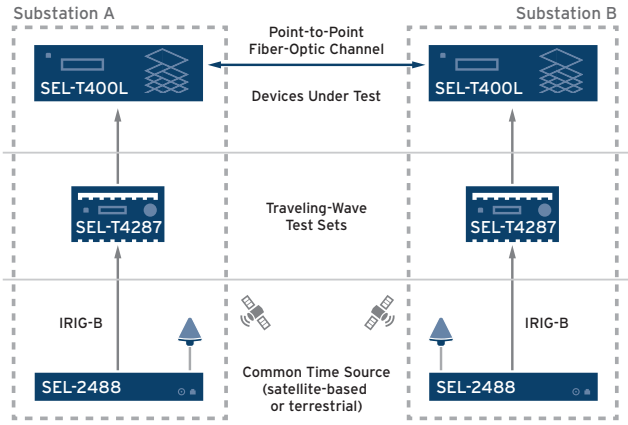
REFRESHING SIMPLICITY

Designed with simplicity in mind, the SEL-T400L minimizes the number of settings and keeps the settings selection as straightforward as possible. The SEL-T400L uses preconfigured, easy-to-set protection logic. The relay requires only a handful of protection settings, and most of them are nameplate data, such as CT and PT ratios, line length and impedance, nominal voltage and frequency, and so on.

The SEL-T400L offers refreshing simplicity compared with feature-heavy multifunction IEDs. This simplicity improves your workforce efficiency and enhances protection security by helping you avoid errors.

TESTING MADE EASY

Requiring only a few protection settings, the SEL-T400L is easy to commission. You can apply any standard relay test set for testing the TD21 distance and TD32 directional elements. The SEL-T4287 Traveling-Wave Test System provides end-to-end testing of the TW87 scheme, the TW32 element, and the traveling-wave fault locator. You can upload ultra-high-resolution current and voltage files (recorded by SEL-T400L relays in the field or obtained from your transient simulation software) to the SEL-T400L and test the relay by executing built-in playback.



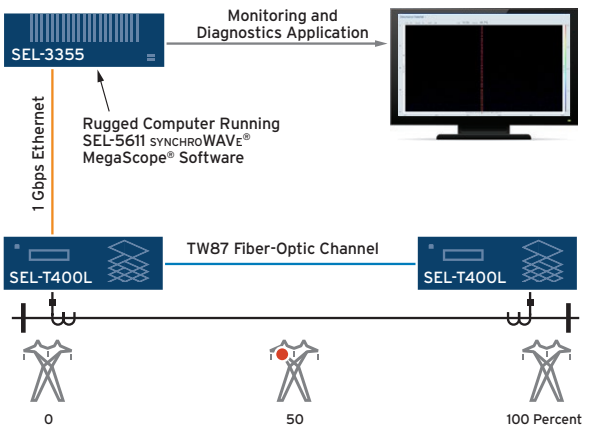
The SEL-T4287 generates nanosecond-timed traveling-wave currents. Perform end-to-end testing with two SEL-T4287 test sets synchronized via satellite clocks.

HASSLE-FREE INSTALLATION

Use the SEL-T400L with standard control cables and wiring to connect to conventional current and voltage transformers, including coupling capacitor voltage transformers (CCVTs), and directly to breaker trip coil circuits. The relay uses current traveling waves that are adequately measured with standard CTs and cabling, providing dependable TW32 operation. The SEL-T400L includes SEL protocols for ease of integration with SEL systems; DNP3 over Ethernet for interconnecting with DNP3-based SCADA systems; generic Ethernet file transfer methods for ease of integration with Ethernet-based substation automation systems; and access to relay metering data.

MEGASCOPE® APPLICATIONS FOR REMOTE MONITORING AND DIAGNOSTICS

With voltages and currents sampled at an unprecedented rate and resolution (1 MHz, 18 bits), the SEL-T400L is a power data acquisition device for advanced remote monitoring and diagnostics applications. The relay streams the high-resolution FTDV data in real time via a Gigabit Ethernet port, opening a whole suite of new applications for viewing power system events. These applications run in real time on high-performance computing platforms, such as the SEL-3355 Computer. You can record and analyze insulation problems, breaker transient voltage recovery or restrike events, switching events, and other high-frequency signatures over wide areas using the SEL-T400L data. For the first time, you have the ability to monitor your system continually across multiple buses at a 1 MHz sampling rate. Contact SEL (**selinc.com/support**) to obtain a detailed format description and tools (such as the preliminary MegaScope client software) to experiment with this advanced SEL-T400L functionality.



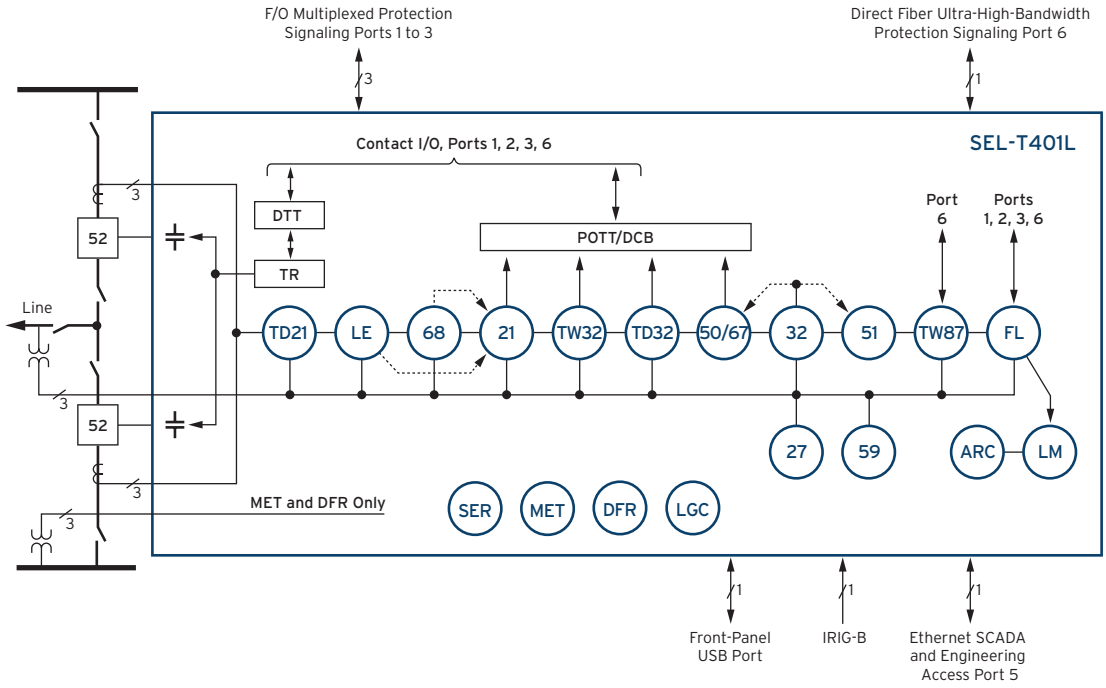
SEL-T401L NEW

ULTRA-HIGH-SPEED LINE RELAY

Starting Price
$15,000 USD

selinc.com/products/T401L
Select models typically ship in 2 days

The SEL-T401L provides ultra-high-speed protection of transmission lines by using field-proven traveling-wave and incremental-quantity technologies pioneered in the SEL-T400L Time-Domain Line Protection. The SEL-T401L trips in 1 to 5 ms, samples at 1 MHz, processes data every microsecond, uses high-speed protection signaling, and trips with solid-state trip-rated outputs. It also offers high-performance distance protection with five zones of ground and phase elements and has dependable protection, flexible programming, and supervisory functions. You can apply the SEL-T401L on its own or as part of a redundant protection system with other SEL relays without concern for common-mode failures.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21	Phase and Ground Distance
TD21	Incremental-Quantity Phase and Ground Distance
27	Undervoltage
32	Directional (Phase, Zero Seq., and Negative Seq.)
TD32	Incremental-Quantity Directional
TW32	Traveling-Wave Directional
50	Instantaneous Overcurrent (Phase, Zero Seq., and Negative Seq.)
51	Inverse-Time Overcurrent (Phase, Zero Seq., and Negative Seq.)
59	Overvoltage (Phase, Zero Seq., and Negative Seq.)
67	Instantaneous and Definite-Time Directional Overcurrent (Phase, Zero Seq., and Negative Seq.)
68	Power-Swing Blocking and Out-of-Step Tripping
85 RIO	SEL MIRRORED BITS® I/O
TW87	Traveling-Wave Differential
94	High-Speed Trip-Rated Outputs
DTT	Direct Transfer Trip Logic (Intertripping)
POTT	Permissive Overreaching Transfer Trip Logic
DCB	Directional Comparison Blocking Logic
LOP	Loss-of-Potential Logic
OP	Open-Pole Detection Logic
LDE	Load Encroachment
DFR	Digital Fault Recorder
SER	Sequential Events Recorder
FL	Fault Locator
LM	Line Monitor
LGC	SELOGIC® Control Equations
TR	Preconfigurable Trip Logic
MET	Metering
ARC	Adaptive Autoreclose Cancel Logic
HMI	Local Operator Interface
DNP	Distributed Network Protocol 3.0 (Ethernet)
FTP	File Transfer Protocol
FTDV	Fast Time-Domain Values
EMI	Electromagnetic Interference Monitoring for Traveling-Wave Functions

ADDITIONAL FUNCTIONS
Arming and Starting Logic for Time-Domain Protection
Traveling-Wave Test Mode
Event Playback
Weak-Infeed Logic
Open Breaker Echo

SEL-T401L OVERVIEW

USB 2.0 port for local engineering access.

Display for viewing metering, event, fault location, and relay status information.

Large slide-in label pocket for diagrams or asset information.

Simple HMI navigation.

LED targets for viewing trip cause, fault type, and basic relay status.

Eight outputs for POTT, DCB, DTT, breaker failure initiation (BFI), and other signaling.

IRIG-B time input.

Three fiber-optic ports for multiplexed protection signaling (SEL MB8 or IEEE C37.94).

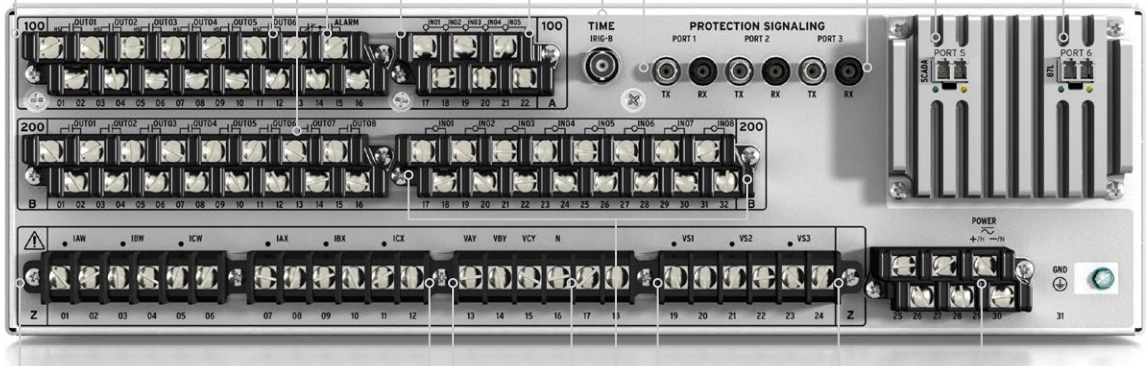
Alarm output.

Six trip-rated high-speed outputs for per-pole tripping of two breakers.

Five contact inputs with a common terminal.

100 Mbps or 1 Gbps small form-factor pluggable (SFP) Ethernet port for engineering access and SCADA.

SFP fiber-optic port for ultra-high-bandwidth protection signaling over direct fiber.



Breaker 1 and 2 current inputs (1 A or 5 A).

Line voltage.

Auxiliary voltage (metering and digital fault recorder).

Power supply: 125—250 Vdc, 110—240 Vac; or 48—125 Vdc, 110—120 Vac.

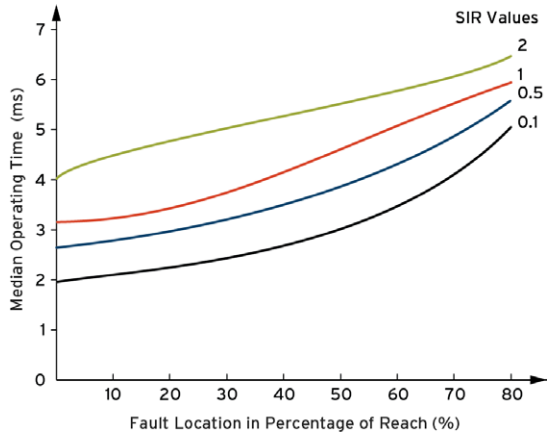
Eight inputs for POTT, DCB, DTT, triggering, and other signaling.

TIME-DOMAIN PROTECTION

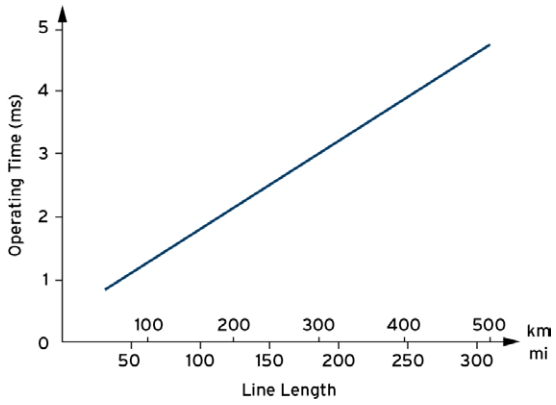
In power system protection, every millisecond counts. Faster fault clearing improves public and utility personnel safety, widens transient stability margins, limits equipment wear, improves power quality, and confines property damage. Using field-proven traveling-wave and incremental-quantity technologies pioneered in the SEL-T400L, the SEL-T401L trips in 1 to 5 ms. The underreaching distance (TD21) protection element trips using incremental voltages and currents. Not dependent on a protection channel, the TD21 element operates as fast as 2 ms for heavy close-in faults. The incremental-quantity directional (TD32) element is dependable and operates in 1 to 2 ms. The traveling-wave directional (TW32) element operates as fast as 0.1 ms. A field-proven SEL innovation, the traveling-wave differential (TW87) protection scheme uses current traveling waves to detect in-zone faults with operating times in the range of 1 to 5 ms, depending on the line length.

The SEL-T401L offers the same capabilities as the field-proven SEL-T400L, including:

- Single- and double-ended traveling-wave and impedance-based fault locating that is accurate to a single tower span, making it possible to find and fix faults fast.
- Autoreclose cancel logic, allowing you to distinguish faults on overhead line sections from faults on underground cable sections and to control your autoreclose logic accordingly.
- High-resolution voltage and current recording with a 1 MHz sampling rate and an 18-bit resolution, providing a detailed view of your system.
- Built-in current and voltage playback, giving you new opportunities for relay testing.



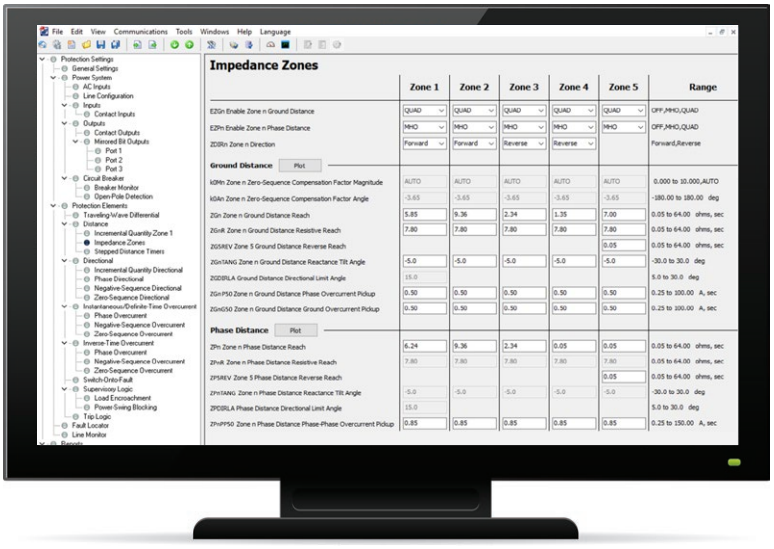
TD21 operating time for a varying fault location under different source-to-line impedance ratios.



TW87 operating time as a function of line length.

REFRESHING SIMPLICITY

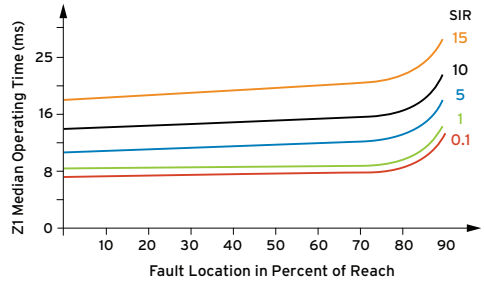
The SEL-T401L allows you to reset the complexity of your line protection applications with its simple and robust protection philosophies and a considerably lower setting count, all in a convenient 3U package. The SEL-T401L design balances flexibility and ease of use. Settings are streamlined, named, grouped, and presented for intuitive application and ease of use. Apply the relay with preconfigured logic, or adjust the factory defaults with SELOGIC control equations with gates, timers, and latches.



DEPENDABLE, FLEXIBLE, AND SIMPLE PROTECTION

Distance Protection

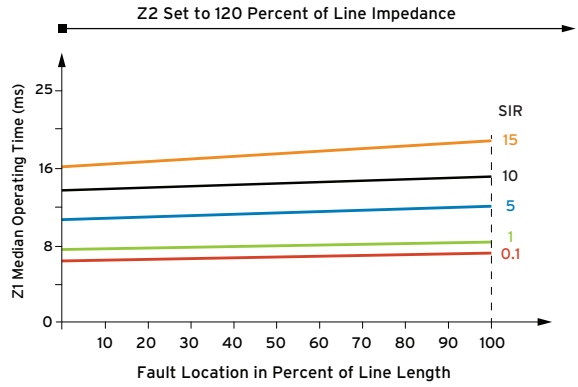
Apply five distance zones for line protection and remote backup. Individually selectable as mho or quadrilateral, forward or reverse, the SEL-T401L distance elements allow you to implement a desired fault resistance coverage philosophy and coordinate well with load and adjacent relays. Use integrating timers and benefit from the enhanced voltage memory polarizing logic to achieve dependable step distance protection. With simple and robust polarizing methods and just a few settings, the SEL-T401L distance elements are easy to apply and test.



Zone 1 operating time for a varying fault location under different source-to-line impedance ratios.

Pilot Tripping Logic

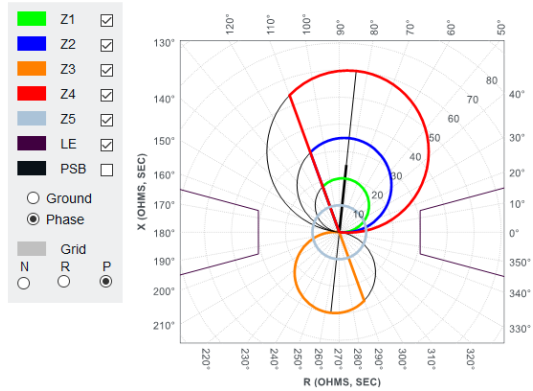
The SEL-T401L offers fast, secure, dependable, and flexible yet easy-to-use POTT and DCB schemes. Select traveling-wave (TW32), incremental quantity (TD32), negative-sequence (32Q), zero-sequence (32G), or phase (32P) directional elements as well as overreaching distance elements (Zone 2) to detect line faults. A combination of the time-domain TW32 and TD32 elements (speed), the sequence-based 32Q and 32G elements (speed, dependability, and sensitivity), and the distance elements (speed and dependability) allows your POTT scheme to trip with extraordinary speed, iron-clad dependability, and very high sensitivity. Enable open breaker echo and weak-infeed logic in your POTT scheme for dependability on tapped and multiterminal lines and during weak system conditions.



Zone 2 operating time for a varying fault location under different source-to-line impedance ratios.

Supplementary and Backup Protection

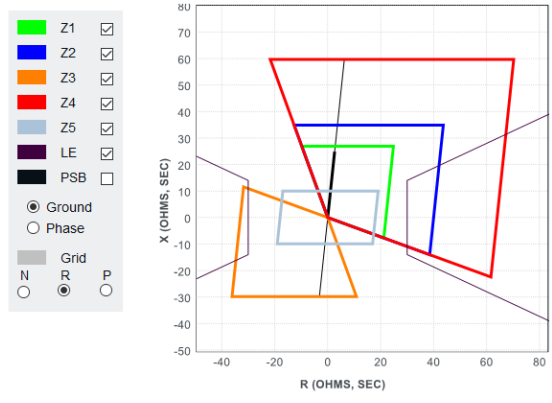
The SEL-T401L offers all core protection elements that you typically want duplicated between the primary and backup relays in a flexible yet easy-to-use package. Cover high-resistance faults through inverse-time and definite-time ground directional overcurrent elements (zero- and negative-sequence). Use phase, zero-, and negative-sequence instantaneous overcurrent elements to clear heavy close-in faults without reliance on voltage or protection channels. Use the inverse-time and definite-time overcurrent elements to coordinate with adjacent relays for backup protection. Use over- and undervoltage instantaneous and time-delayed voltage elements to address out-of-bound voltage system conditions.



SEL-T401L distance mho operating characteristics.

Supervisory Elements

Apply load-encroachment logic to secure the SEL-T401L distance and phase overcurrent elements for heavy load conditions. Optimize your single-pole tripping applications by applying separate load-encroachment settings for the phase and ground measurement loops. Apply the power-swing blocking logic to secure the SEL-T401L distance elements during power swings. Phase-segregated operation allows dependable blocking of ground elements for power swings under external unbalance conditions, such as single-pole tripping and reclosing on adjacent lines. Two separate unblocking mechanisms allow dependable SEL-T401L operation for faults during power-swing conditions. Apply the out-of-step tripping logic to trip for unstable power swings traversing the protected line. The out-of-step tripping logic is settings-free and applies a simple trip-on-the-way-out operating principle based on the impedance-rate-of-change measurement.



SEL-T401L distance quadrilateral elements with load encroachment.

SEL-T4287

TRAVELING-WAVE TEST SYSTEM

Starting Price
$4,287 USD

selinc.com/products/T4287
Select models typically ship in 2 days

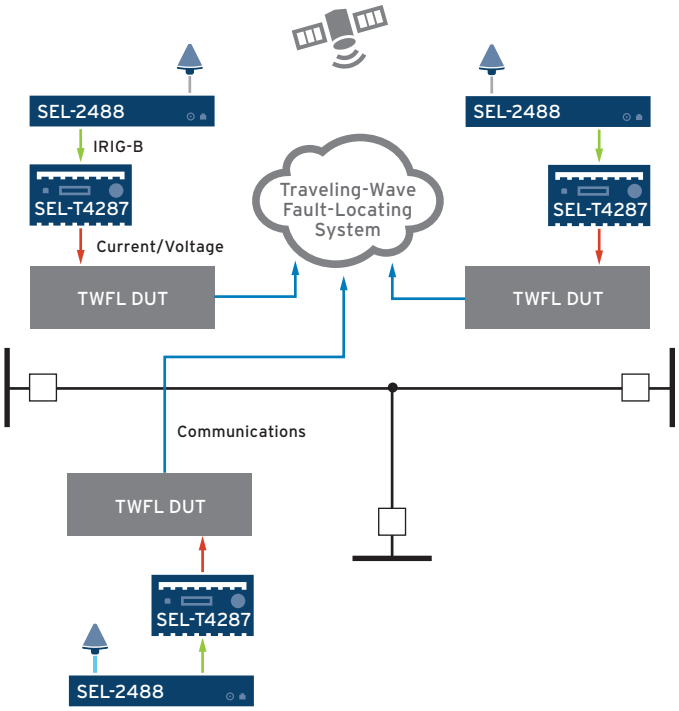
The SEL-T4287 is a simple-to-use, compact, and economical secondary pulse injection test set for traveling-wave fault locators and line protective relays.

Secondary Traveling-Wave Injection—Traveling-wave fault locators and protection elements and schemes measure sharp changes in their input currents and voltages with rise times as fast as 1 µs. These fault locators and relays respond to relative polarities and the relative timing of these sharp signal changes. The SEL-T4287 generates output current signals with a short rise time, adequately slow decay, and the nanosecond precision necessary for testing traveling-wave protective relays, standalone traveling-wave fault locators, and traveling-wave fault locators embedded in line protective relays.

Versatile Applications—The SEL-T4287 generates two three-phase sets of secondary traveling-wave currents. An included voltage module accessory (containing low-inductance resistors) allows you to convert one current output set into one voltage output set to simulate traveling-wave voltage signals. The SEL-T4287 lets you test current- or voltage-based fault locators or protection elements and schemes, including single- and multi-ended fault locators, a traveling-wave directional element, and a traveling-wave differential scheme. You can time-synchronize or cross-trigger multiple SEL-T4287 test sets to generate more than two three-phase traveling-wave signals with desired timing patterns as needed by the device under test (DUT).

Simple Test Parameter Configuration—Specify line and fault parameters, and let the SEL-T4287 calculate and apply the traveling-wave test signals. The simple and intuitive SEL-T4287 HMI allows you to specify test parameters and offers full control of tests without the need for a PC and software.

End-to-End Testing—Perform end-to-end testing of traveling-wave protection schemes and multi-ended fault locators with multiple SEL-T4287 test sets synchronized to substation satellite clocks via IRIG-B inputs. You can preconfigure each test set, schedule a test time, and let the multiple SEL-T4287 test sets apply the right test signals at all terminals of the line. The SEL-T4287 can test multi-ended traveling-wave fault locators for lines with more than two terminals. End-to-end testing is a standard feature included in the base product and can be used with any IEEE C37.118-compliant satellite clock with IRIG-B output.



End-to-end testing of a multi-ended fault-locating system.

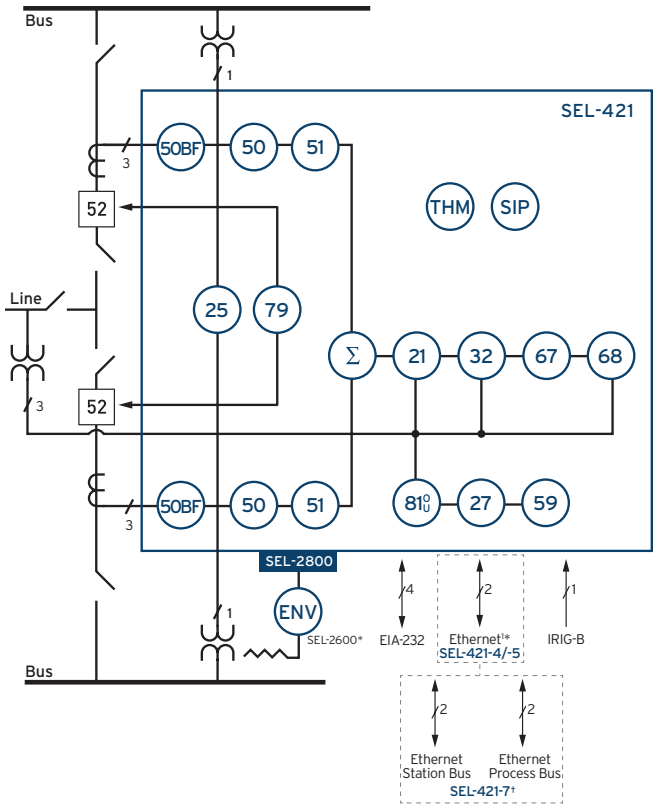
SEL-421

PROTECTION, AUTOMATION, AND CONTROL SYSTEM

Starting Price
$6,930 USD

selinc.com/products/421

The SEL-421 provides high-speed distance and directional protection and complete control of a two-breaker bay. You can protect any transmission line using a combination of five zones of phase- and ground-distance and directional overcurrent elements. A graphical user interface provides logic and application templates for typical line protection schemes. Patented capacitively coupled voltage transformer (CCVT) transient overreach logic enhances the security of Zone 1 distance elements. Best Choice Ground Directional Element® logic optimizes directional element performance and eliminates many directional settings. Optional additional logic prevents Zone 1 overreach on series-compensated lines. In addition, you can select incremental components for subcycle operation on critical lines requiring high-speed fault clearing. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology using IEC 61850-9-2 transform the way you modernize your substation.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21	Phase and Ground Distance
25	Synchronism Check
27	Undervoltage
32	Directional Power
50	Overcurrent
50BF	Dual Breaker Failure Overcurrent
51	Time Overcurrent
59	Overvoltage
67	Directional Overcurrent
68	Out-of-Step Block/Trip
79	Single-/Three-Pole Reclosing
81 (O,U)	Over-/Underfrequency
85 RIO	SEL MIRRORED BITS® Communications
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	Expanded SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDE	Load Encroachment
LOC	Fault Locator
SBM	Station Battery Monitor
SIP	Software-Invertible Polarities
SV	IEC 61850-9-2 Sampled Values Technology*†
THM	IEC 60255-Compliant Thermal Model
TiDL	Time-Domain Link Technology*

*Optional feature †Copper or fiber-optic

†SV subscriber relays have no analog input boards and instead receive voltages and current through Ethernet.

EIA-232 front serial port is quick and convenient for system setup and local access.

Front-panel display allows operators to control and view the status of disconnects and breakers.

Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.

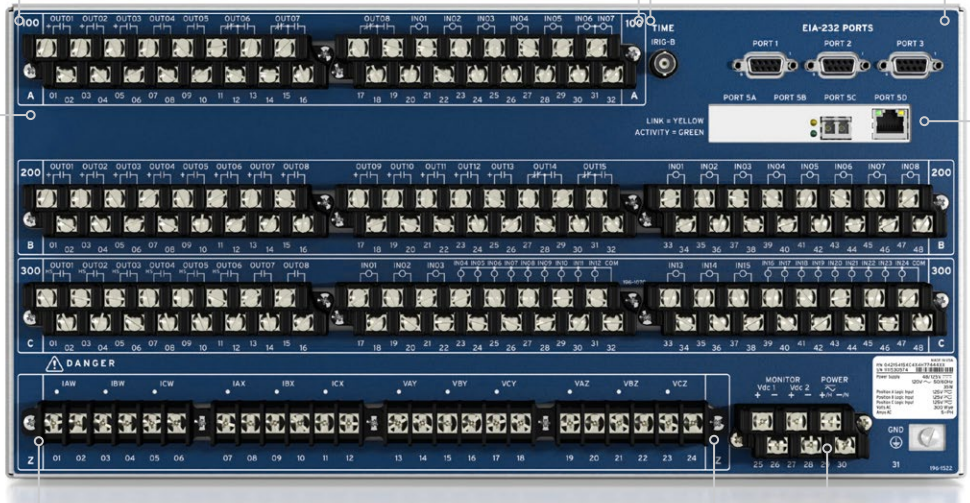
User-selectable mimic screens show the system configuration in one-line diagram format.

Programmable operator push-buttons with user-configurable labels allow front-panel customization.

Easy-to-use keypad aids simple navigation.

High-current interrupting output contacts increase contact robustness and reliability.

Use one front and three rear EIA-232 ports for MIRRORED BITS communications, DNP3, SCADA, and engineering access.



Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.

Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, PRP, IEEE 1588 PTPv2,** and IEC 61850 Edition 2.

Six current and six voltage analog inputs support complete bay control and protection as well as two-breaker bay applications.

Power supply options include 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.

SEL-421 OVERVIEW—TIDL OPTION

Commission button usage prompts the relay to communicate with the remote TiDL nodes.

4U chassis with mounting options (vertical or horizontal; panel or rack) accommodate users' application needs.

LEDs indicate the connection status to a remote TiDL node on a per-port basis

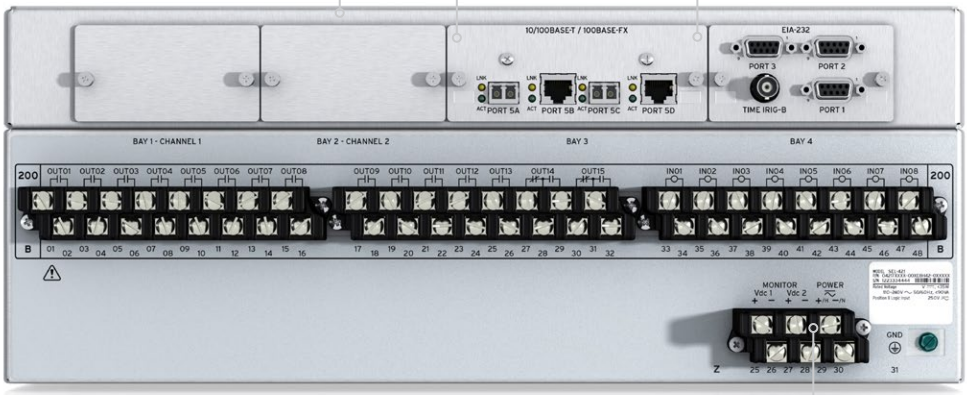
LEDs indicate a valid configuration and successful commissioning.

Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote TiDL nodes and to receive remote analog and digital data over the network.

SEL-421 OVERVIEW—SV OPTION

The 4U chassis has various mounting options to accommodate users' hardware needs.

Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.



Power supply options include 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

SEL-411L

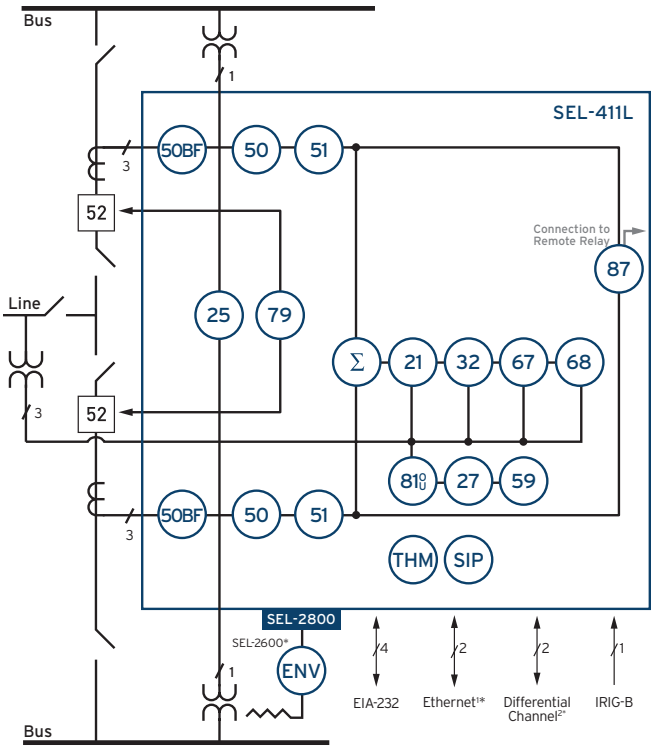
ADVANCED LINE DIFFERENTIAL PROTECTION, AUTOMATION, AND CONTROL SYSTEM

Starting Price
$8,515 USD

selinc.com/products/411L

The SEL-411L offers complete protection and control of any transmission line (short, long, or series-compensated) with up to four terminals. Differential protection with both phase- and sequence-based operating elements provides sensitivity and high-speed operation. Complete distance and directional elements provide standalone protection or backup protection in differential schemes in the event communications are lost.

In addition to the differential protection, the SEL-411L includes all the features of the SEL-421 Protection, Automation, and Control System. Many popular fiber and multiplexed communications options are available. The SEL-411L accurately locates faults to within a tower span using optional traveling-wave fault locating.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21	Phase and Ground Distance
25	Synchronism Check
27	Undervoltage
32	Directional Power
50	Overcurrent
50BF	Dual Breaker Failure Overcurrent
51	Time Overcurrent
59	Overvoltage
67	Directional Overcurrent
68	Out-of-Step Block/Trip
79	Single-/Three-Pole Reclosing
81 (O,U)	Over-/Underfrequency
85 RIO	SEL MIRRORED BITS® Communications
87	Current Differential
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	Expanded SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDE	Load Encroachment
LOC	Fault Locator
SBM	Station Battery Monitor
SIP	Software-Invertible Polarities
THM	IEC 60255-Compliant Thermal Model

*Optional feature [1]Copper or fiber-optic [2]Serial or Ethernet

SEL-411L OVERVIEW

EIA-232 front serial port is quick and convenient for system setup and local access.

Easy-to-use keypad aids simple navigation.

Programmable operator pushbuttons with user-configurable labels allow front-panel customization.

Front-panel display allows operators to control and view the status of disconnects and breakers.

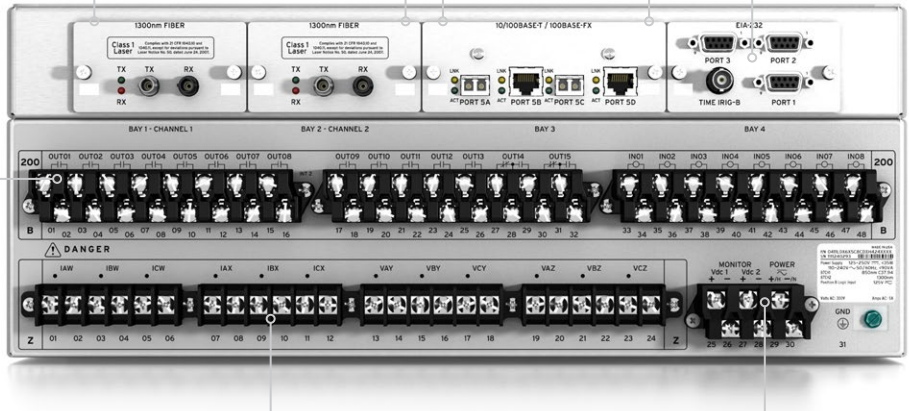
User-selectable mimic screens show the system configuration in one-line diagram format.

Up to 24 programmable target LEDs with user-configurable labels alert operators in the substation to faulted phases, the relay's status, and element operation.

Choose either fiber or copper connections for one or two 87L communications channels.

Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, PRP, IEEE 1588 PTPv2,** and IEC 61850 Edition 2.

Three EIA-232 serial ports for MIRRORED BITS communications, SCADA, and engineering access provide flexibility to communicate with other devices and control systems. The ports include demodulated IRIG-B for precise-time input.



Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.

Six current and six voltage analog inputs support protection for substations with dual-breaker schemes.

The power supply allows different options: 48—125 Vdc or 110—120 Vac, or 125—250 Vdc or 120—240 Vac.

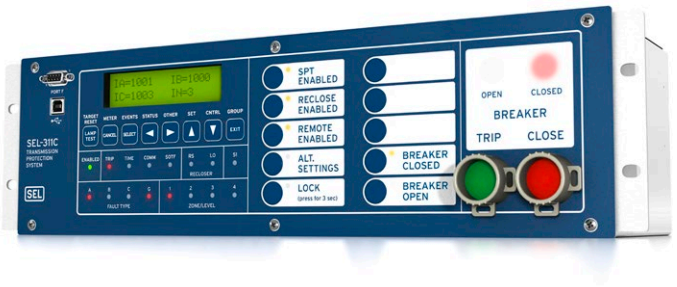
**For PTPv2 implementation, Ports 5A and 5B must be used for engineering access and SCADA.

SEL-311C

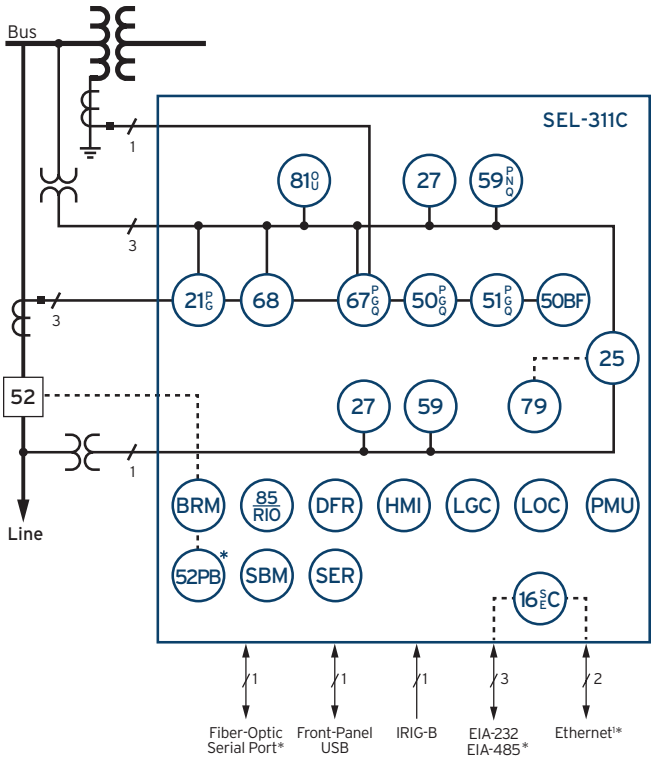
TRANSMISSION PROTECTION SYSTEM

Starting Price
$4,510 USD

selinc.com/products/311C



The SEL-311C provides protection, reclosing, monitoring, and control of transmission lines. Features include a four-shot recloser; patented capacitance voltage transformer (CVT) transient overreach logic to enhance the security of Zone 1 distance elements; and overcurrent elements with directional control, monitoring, and metering. You can apply three-pole tripping logic or select the SEL-311C-3 for single-pole tripping. The SEL-311C comes standard with EIA-232 serial ports and a 10/100BASE-T Ethernet port for local/remote access and system integration. IEEE C37.118-compliant synchrophasors improve situational awareness.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
21 (P,G)	Distance (Phase Mho, Ground Mho, Ground Quad)
25	Synchronism Check
27	Undervoltage
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
50BF	Breaker Failure Overcurrent
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
52PB	Trip/Close Pushbuttons*
59 (P,N,Q)	Overvoltage (Phase, Neutral, Negative Sequence)
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Negative Sequence)
68	Out-of-Step Block/Trip
79	Autoreclosing
81 (O,U)	Over-/Underfrequency
85 RIO	SEL Mirrored Bits® Communications
DFR	Event Reports
HMI	Operator Interface
LGC	Expanded SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDE	Load Encroachment
LOC	Fault Locator
SBM	Station Battery Monitor

*Optional feature

!Copper or fiber-optic

Simplify local connection and speed up relay communications with the front-panel USB port.

Use default displays, or program custom messages.

Optional field-configurable, programmable operator pushbuttons with user-configurable labels.

Mirrored Bits communications.

Built-in phasor measurement unit.

Optional programmable front-panel LEDs for custom alarms.

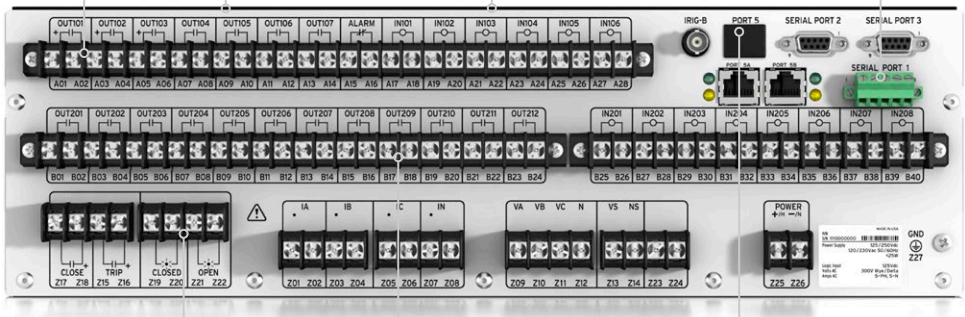
Optional independent SafeLock® trip/close pushbuttons with high-visibility indication.

High-current interrupting output contacts.

Advanced SELogic control equations.

Standard multisession Modbus TCP and DNP3. Optional IEC 61850.

Standard EIA-485 or fiber-optic serial port, or optional fiber-optic serial port.



Independent terminals for SafeLock trip/close pushbuttons.

Optional expanded I/O.

Standard dual copper, optional single or dual fiber-optic Ethernet ports, or one copper and one fiber-optic Ethernet port.

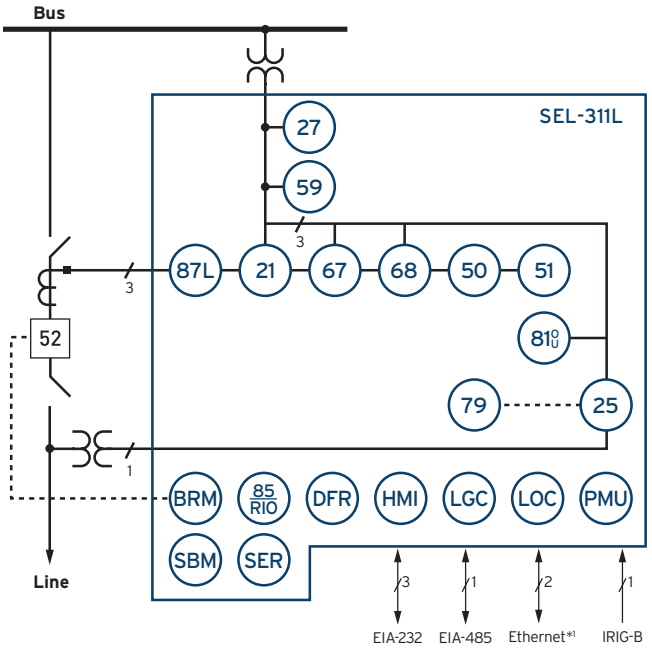
SEL-311L

LINE CURRENT DIFFERENTIAL PROTECTION AND AUTOMATION SYSTEM

Starting Price
$5,000 USD

selinc.com/products/311L

The SEL-311L offers four-zone distance and directional overcurrent backup for easy-to-apply, high-speed line current differential protection. Single or dual differential communications channels provide reliability and security. The SEL-311L can accommodate two- or three-terminal lines, even with weak infeed. In addition, measuring elements provide coordination with tapped loads. You can reduce total project construction and operation costs by integrating the included four-shot recloser and relay logic operators into your automation system.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21	Phase and Ground Distance
25	Synchronism Check
27/59	Under-/Overvoltage
50	Overcurrent
51	Time Overcurrent
67	Directional Overcurrent
68	Out-of-Step Block/Trip
79	Single-/Three-Pole Reclosing
81 (O,U)	Over-/Underfrequency
85 RIO	SEL Mirrored Bits® Communications
87L	Current Differential
DFR	Event Reports
HMI	Operator Interface
LGC	SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDE	Load Encroachment
LOC	Fault Locator
SBM	Station Battery Monitor

*Optional feature [1]Copper or fiber-optic

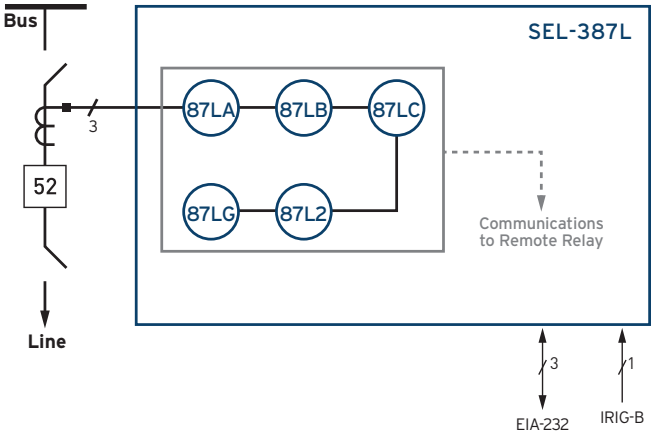
SEL-387L

LINE CURRENT DIFFERENTIAL RELAY

Starting Price
$2,940 USD

selinc.com/products/387L

The SEL-387L offers sensitive, fast (subcycle), and secure three-pole current differential protection with zero settings. Negative- and zero-sequence differential elements detect high-resistance ground faults while remaining secure for external faults. The Alpha Plane restraint principle provides security for CT saturation and channel asymmetry. Direct fiber and IEEE C37.94 synchronous optical interfaces are available. Channel monitoring provides measurement of communications quality and prevents misoperation due to channel failure.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
87L	Current Differential
DFR	Event Reports
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
SER	Sequential Events Recorder
SBM	Station Battery Monitor

SUBSTATION PROTECTION OVERVIEW

SEL-787-2/-3/-4

Apply advanced protection and monitoring with flexible communications to two-, three-, and four-terminal transformers.

SEL-401

Apply the SEL-401 for substations with IEC 61850-9-2 Sampled Values (SV) systems. The SEL-401 is a standalone merging unit with phase overcurrent and breaker failure protection.

SEL-421-7

Employ the SEL-421-7 in substations with IEC 61850-9-2 SV systems. The SEL-421-7 is the only standalone merging unit in the world with complete line protection built in.

SEL-487V

Protect and control grounded and ungrounded, single- and double-wye capacitor bank configurations.

SEL-487E

Provide high-speed transformer differential protection for up to five terminals as well as advanced monitoring, metering, automation, and control.

SEL-2414

Provide complete system monitoring and control for new and existing transformers.

SEL-487B

Provide bus differential and breaker failure protection, automation, and control in applications with up to seven terminals per relay.

SEL-587Z

Use the economical SEL-587Z to combine proven high-impedance analog technology with the advantages of microprocessor technology.

SEL-352

Provide breaker failure protection and breaker control and monitoring with unparalleled flexibility.

TRANSFORMER PROTECTION AND MONITORING

	SEL-487E	SEL-387E	SEL-387	SEL-387A	SEL-787	SEL-787-2X/-21/-2E	SEL-787-3E/-3S/-4X	SEL-587	SEL-2414
APPLICATIONS									
Breaker Failure Protection	•	f	f	f	•	•	•	f	f
Transformer and Machine Current Differential	•	•	•	•	•	•	•	•	
Low-Impedance Bus Differential	•	•	•				•		
Underfrequency Load Shedding	•	f			+	+	+		
Undervoltage Load Shedding	•	f			+	+	+		
Three-Phase Current Inputs	5	3	4	2	2	2*	3 or 4	2	3*
Three-Phase Voltage Inputs	2	1			1*	1*	1*		1*
PROTECTION									
24 Overexcitation (Volts/Hertz)	•	•			+	+	+		
25 Synchronism Check	•						+		
27/59 Under-/Overvoltage	•	•			+	+	+		
32 Directional Power	•				+	+	+		
46 Current Unbalance	•								
49 Equipment Thermal Monitoring	•		+	•	•	•	•		
50FO Flashover Protection	f	f			f	f	f		
50 (N,G) Overcurrent (Neutral, Ground)	•	•	•	•	•	•	•	•	
50P Phase Overcurrent, 50Q Negative-Sequence Overcurrent	•	•	•	•	•	•	•	•	
51 (N,G) Time Overcurrent (Neutral, Ground)	•	•	•	•	•	•	•	•	
51P Phase Time Overcurrent	•	•	•	•	•	•	•	•	
51Q Negative-Sequence Time Overcurrent	•	•	•	•	•	•	•	•	
67 (P,G,Q) Directional Overcurrent (Phase, Ground, Negative Sequence)	•								
81 Under-/Overfrequency	•	•			+	+	+		
81R Rate-of-Change of Frequency	f								
87 Current Differential	•	•	•	•	•	•	•	•	
REF Restricted Earth Fault	•	•	•	+	+	+	•		
INSTRUMENTATION AND CONTROL									
SELOGIC® Control Equations	•	•	•	•	•	•	•	•	•
Voltage Check on Closing	f	f			f	f	f		
Transformer Cooling Fan Control	f				f	f	f		•
Nonvolatile Latch Control Switches	•	•	•	•	•	•	•		•
SELOGIC Remote Control Switches	•	•	•	•	•	•	•	•	•
SELOGIC Local Control Switches	•	•	•	•	•	•	•		•
Display Points	•	•	•	•	•	•	•		•
Multiple Settings Groups	•	•	•	•	•	•	•		
Substation Battery Monitor	•	•	•	•		+	+		f
Breaker Wear Monitor	•	•	•	•		•	•		
Event Report (Multicycle Data)	•	•	•	•	•	•	•	•	•
Sequential Events Recorder	•	•	•	•	•	•	•		•
Instantaneous and Demand Meter	•	•	•	•	•	•	•	•	•
Load and Temperature Profile Report	•				•	•	•		•
RTD (Resistance Temperature Detector) Inputs					+	+	+		+
Built-In Web Server	•	•				•	•		
Software-Invertible Polarities	•								
IEC 60255-Compliant Thermal Model	•								
IEEE C37.118 Synchrophasors	•				•	•	•		
IEC 61850	+	+			+	+	+		+
IEC 61850-9-2 Sampled Values Technology	+								
Simple Network Time Protocol (SNTP)	•				•	•	•		
Parallel Redundancy Protocol (PRP)	•				+	+	+		
IEEE 1588 Precision Time Protocol Version 2 (PTPv2)	+					•	•		
Time-Domain Link (TiDL®) Technology	+								
Through-Fault Monitor	•	•	+	•	•	•	•		•
Thermal Model/SEL-2600 RTD Module Communications	•		+	•	•	•	•		•

• Standard feature + Model option

f May be created using relay elements, device word bits, analog quantities, and timers

BUS PROTECTION

	SEL-387	SEL-487B	SEL-487E	SEL-587Z
APPLICATIONS				
Breaker Failure Protection	f	•	•	f
Bus Differential	f	•	•	•
Transformer and Machine Current Differential	•		•	
High-Impedance Bus Differential				•
Low-Impedance Bus Differential	•	•	•	
Three-Phase Current Inputs	4	7/10/21‡	5	Common
Three-Phase Voltage Inputs		1	2	
PROTECTION				
27/59 Under-/Overvoltage		•	•	
46 Current Unbalance		f	•	
47 Voltage Unbalance			f	
50 (N,G) Overcurrent (Neutral, Ground)	•		•	•
50P Phase Overcurrent	•	•	•	•
50Q Negative-Sequence Overcurrent	•		•	•
51 (N,G) Time Overcurrent (Neutral, Ground)	•		•	•
51P Phase Time Overcurrent	•	•	•	•
51Q Negative-Sequence Time Overcurrent	•		•	•
87 Current Differential	•	•	•	
87Z High-Impedance Differential				•
Single-Pole Trip/Close		•		
Three-Phase Differential Bus Zones	1	2/3/6‡	1	1
Check Zones		3		
INSTRUMENTATION AND CONTROL				
79 Automatic Reclosing		f	f	
Dynamic Zone Selection		•		
SELOGIC® Control Equations	•	•	•	•
Nonvolatile Latch Control Switches	•	•	•	
SELOGIC Remote/Local Control Switches	•	•	•	•
Display Points	•	•	•	•
Multiple Settings Groups	•	•	•	
Substation Battery Monitor	•	•	•	
Breaker Wear Monitor	•		•	
Event Report (Multicycle Data)	•	•	•	•
Sequential Events Recorder	•	•	•	•
Instantaneous Meter	•	•	•	•
Demand Meter	•		•	•
Through-Fault Monitor	•		•	
Software-Invertible Polarities			•	
IEC 60255-Compliant Thermal Model			•	
IEEE C37.118 Synchrophasors			•	
Synchrophasor Real-Time Control			•	
IEC 61850		+	+	
IEC 61850-9-2 Sampled Values Technology		+	+	
Built-In Web Server		•	•	
Simple Network Time Protocol (SNTP)		•	•	
MIRRORED BITS® Communications		•	•	
Parallel Redundancy Protocol (PRP)		•	•	
IEEE 1588 Precision Time Protocol Version 2 (PTPv2)		+	+	
Time-Domain Link (TiDL®) Technology		+	+	
MISCELLANEOUS FEATURES				
Connectorized® (Quick Disconnect) Available	+	+	+	

• Standard feature + Model option ‡1/2/3 relay application

f May be created using settings

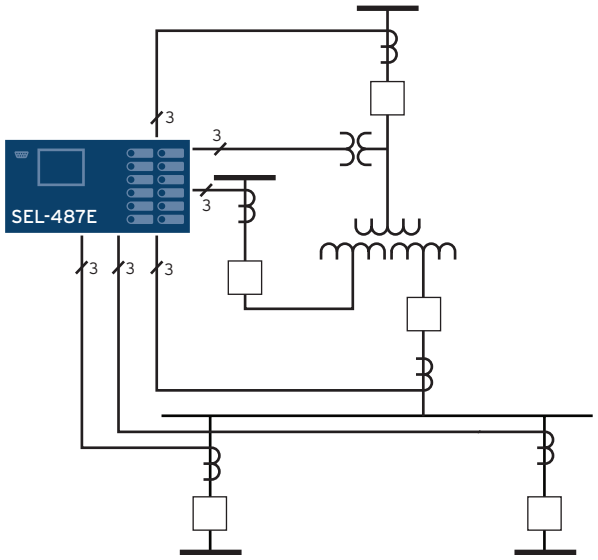
BREAKER FAILURE AND CAPACITOR BANK PROTECTION

	SEL-352	SEL-451	SEL-487B	SEL-487V
APPLICATIONS				
Breaker Failure Protection, Number of Three-Phase Breakers	1	2	7	1
Bus Differential			•	
Shunt Capacitor Bank Protection		f		•
Underfrequency Load Shedding		f		f
Undervoltage Load Shedding	f	f	f	f
PROTECTION				
25 Synchronism Check	•	•		
27/59 Under-/Overvoltage	•	•	•	•
32/37 Power Elements	•	f	f	•
46 Current Unbalance	•	f	f	•
47 Voltage Unbalance		f	f	f
49 Equipment Thermal Monitoring	+	f		f
50FO Flashover Protection	•	•		•
50 (N,G) Overcurrent (Neutral, Ground)	•	•		•
50P Phase Overcurrent	•	•	•	•
50Q Negative-Sequence Time Overcurrent		•		•
51 (N,G) Time Overcurrent (Neutral, Ground)		•		•
51P Phase Time Overcurrent		•	•	•
51Q Negative-Sequence Time Overcurrent		•		•
60 (N,P) Current Unbalance (Neutral, Phase)				•
67 Directional Overcurrent		•		•
81 Under-/Overfrequency		•		•
81R Rate-of-Change of Frequency				•
87 Current Differential			•	
87V Voltage Differential	•	f		•
Single-Pole Trip/Close	•		•	
INSTRUMENTATION AND CONTROL				
Open-Pole Detection		f	f	•
79 Automatic Reclosing	f	•	f	f
SELOGIC® Control Equations	•	•	•	•
Voltage Check on Closing		•		
Nonvolatile Latch Control Switches	•	•	•	•
SELOGIC Remote/Local Control Switches	•	•	•	•
Display Points	•	•	•	•
Multiple Settings Groups	•	•	•	•
Substation Battery Monitor	+	•	•	•
Breaker Wear Monitor	+	•		•
Voltage Sag, Swell, and Interruption (VSSI) Recording		•		•
Event Report (Multicycle Data)	•	•	•	•
Sequential Events Recorder	•	•	•	•
Instantaneous Meter	•	•	•	•
Demand Meter		•		•
Harmonic Metering				•
Software-Invertible Polarities		•		
IEC 60255-Compliant Thermal Model		•		
IEEE C37.118 Synchrophasors		•		•
IEC 61850		+	+	+
IEC 61850-9-2 Sampled Values Technology		+	+	
Built-In Web Server		•	•	•
Simple Network Time Protocol (SNTP)		•	•	•
Parallel Redundancy Protocol (PRP)		•	•	•
IEEE 1588 Precision Time Protocol Version 2 (PTPv2)		+	+	
Time-Domain Link (TiDL®) Technology		+	+	
SEL-2600 RTD Module Communications	+	•		•
MISCELLANEOUS FEATURES				
Connectorized® (Quick Disconnect) Available	+	+	+	+
Synchrophasor Real-Time Control		•		•

• Standard feature + Model option

f May be created using relay elements and timers

TRANSFORMER APPLICATIONS

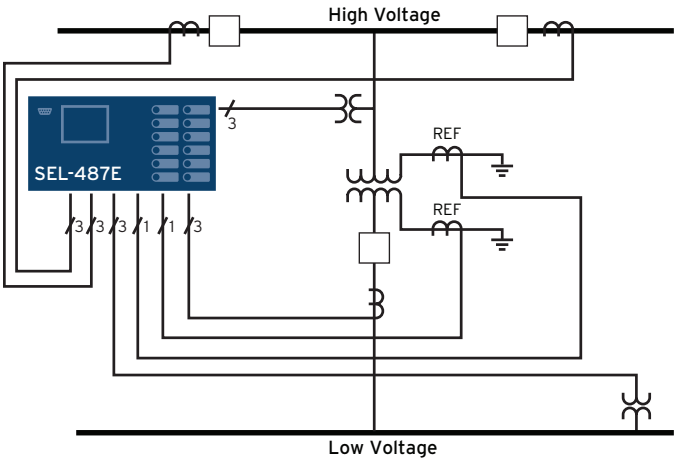


MULTIWINDING TRANSFORMER PROTECTION

Provide current differential protection for up to five windings with an adaptive-slope percentage restraint for transformers at power plants, transmission substations, distribution substations, and industrial plants. The remaining three-phase current inputs can provide feeder backup protection.

Combine harmonic blocking and restraint functions in parallel to provide secure operation during inrush conditions. Second- and fourth-harmonic blocking provides security during energization, while fifth-harmonic blocking provides security for overexcitation conditions. The waveform-based inrush detection method augments the harmonic-blocking and -restraint functions to prevent differential element operation during an inrush condition with low second-harmonic content.

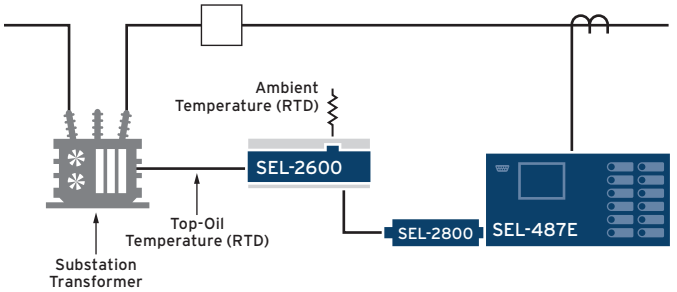
Implement the negative-sequence differential element for sensitive detection of interturn faults within the transformer winding.



IMPEDANCE-GROUNDED TRANSFORMERS

Apply the restricted earth fault (REF) protection feature to provide sensitive detection of internal ground faults on grounded-wye-connected transformer windings and autotransformers. The element is "restricted" in the sense that protection is restricted to ground faults within a zone defined by neutral and line CT placement.

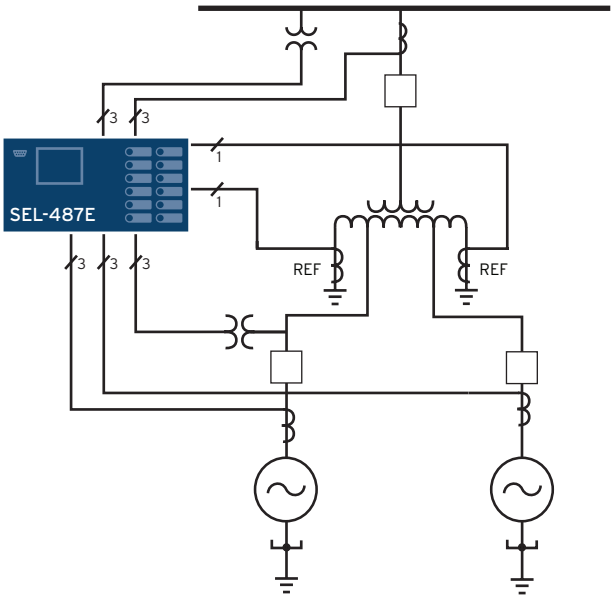
There are three independent REF elements in the SEL-487E Transformer Protection Relay. The SEL-387E Current Differential and Voltage Relay and SEL-387 Current Differential and Overcurrent Relay come standard with an REF element, while this is an optional feature with the SEL-387A Current Differential and Overcurrent Relay and the SEL-787 Transformer Protection Relay.



THROUGH-FAULT AND THERMAL MONITORING

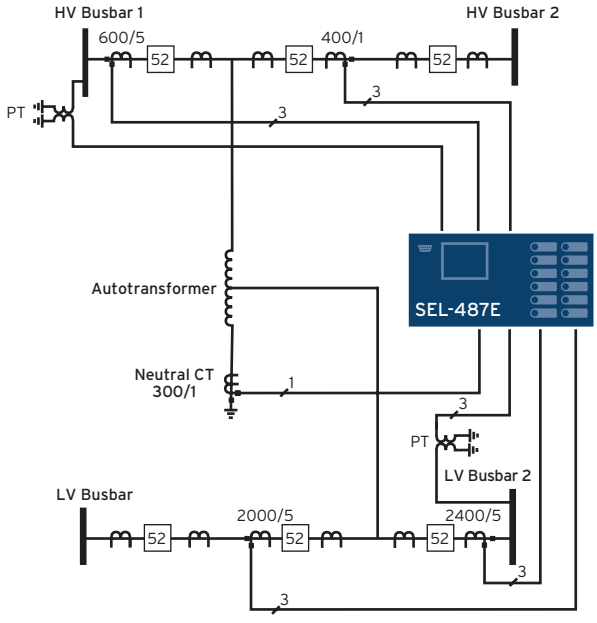
Track transformer wear with through-fault and thermal monitoring using the SEL-2600 RTD Module and SEL-487E. With the thermal element, you can trip the breaker, activate a control action, or issue an alarm when the transformer is in danger of excessive insulation aging or loss-of-life.

Gather current levels, through-fault duration, and the date/time of each through fault with transformer through-fault monitoring. Through-fault currents can cause transformer winding displacement, leading to mechanical damage and increased transformer thermal wear. Monitoring through-fault currents allows you to schedule proactive maintenance based on cumulative through-fault duty.



GENERATOR STEP-UP (GSU) UNITS

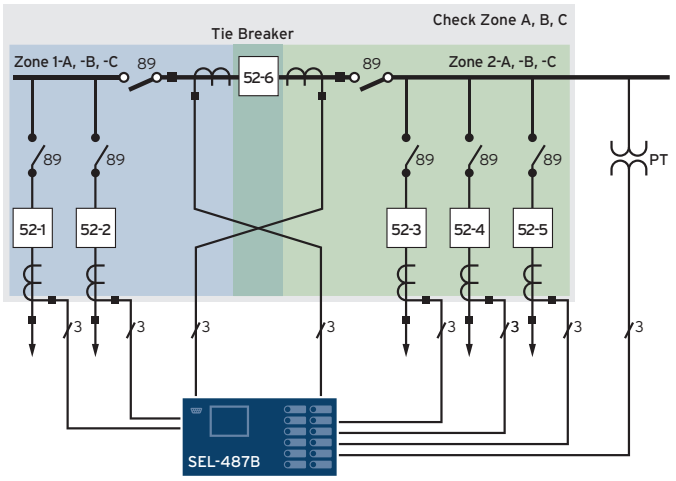
Install the SEL-487E for complete protection of GSU transformer applications. The built-in thermal elements let you monitor both generator and transformer winding temperatures. You can apply the volts/hertz element with two-level settings for overexcitation protection of loaded and unloaded generator operating conditions. The directional power elements detect forward and reverse power flow conditions to monitor and protect the GSU transformer in prime power, standby, base load, and peak-shaving applications.



AUTOTRANSFORMER PROTECTION

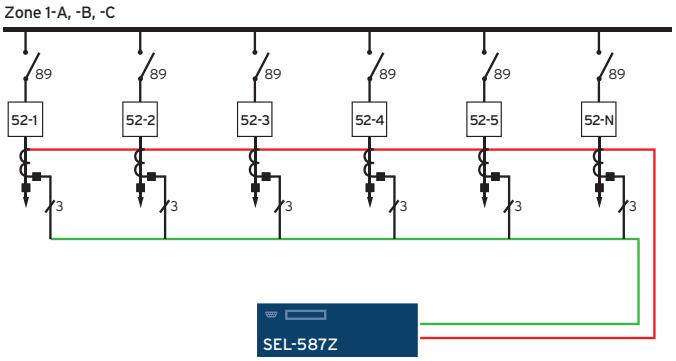
Protect autotransformers, including those with both high-voltage (HV) and low-voltage (LV) busbars configured as breaker-and-a-half busbars. The SEL-487E accepts CT inputs from up to five sets of phase CTs and up to three neutral CTs and accepts PT inputs from both HV and LV busbars. The voltage inputs provide over-/undervoltage elements, frequency elements, power elements, and volts-per-hertz protection of the transformer.

BUS APPLICATIONS



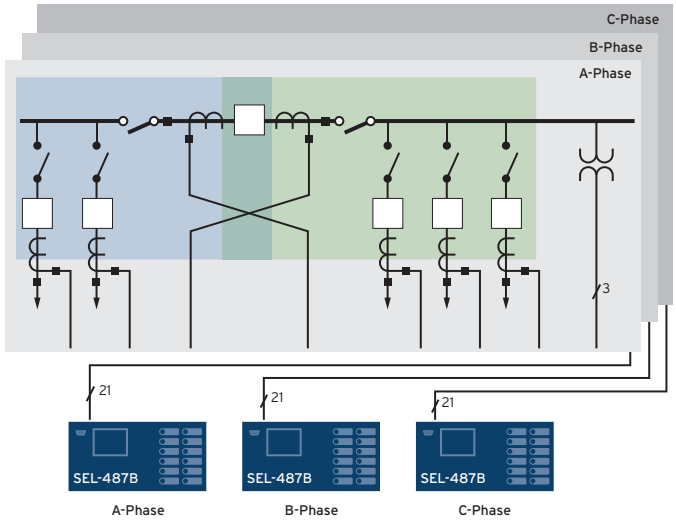
LOW-IMPEDANCE BUS DIFFERENTIAL PROTECTION

Provide two three-phase zones of protection for up to seven three-phase terminals (21 total current inputs) with a single SEL-487B Bus Differential and Breaker Failure Relay. A per-phase check zone increases security. For certain bus topologies, such as breaker-and-a-half, you can use one three-phase voltage input to increase security. The SEL-487B works in systems with nondedicated CTs and CT ratio mismatches up to 10:1, allowing you to use the same CTs in other protection applications. The relay also provides circuit breaker failure protection, control for up to 21 breakers and 60 disconnects, backup overcurrent protection, communications, and programmable logic control options.



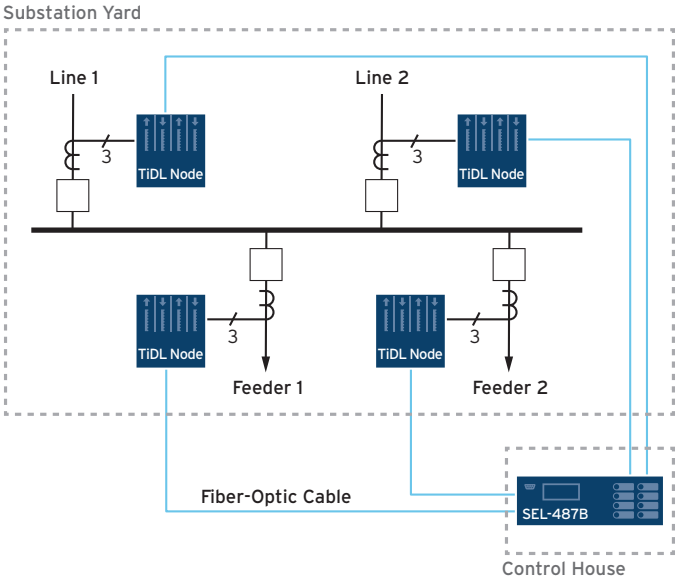
HIGH-IMPEDANCE BUS DIFFERENTIAL PROTECTION

Implement simple and cost-effective bus protection with the SEL-587Z High-Impedance Differential Relay. A single bus zone protects any number of bus terminals since the current inputs are connected in parallel before being brought to the relay. You can create an easily expandable bus protection solution with simple settings and dedicated same-ratio CTs. The relay can also provide backup overcurrent protection, detect breaker failure, and detect open-circuit CT conditions.



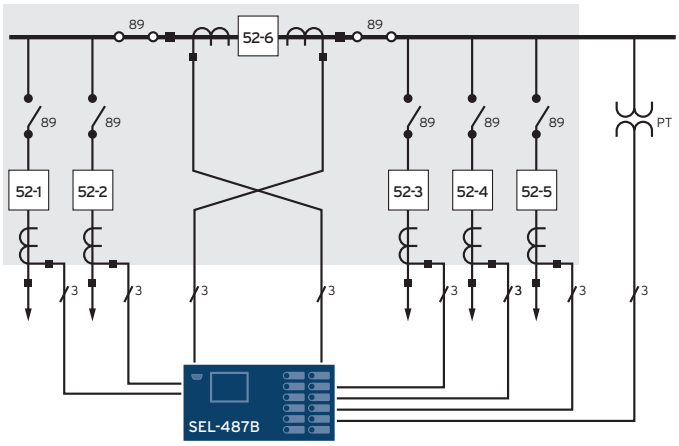
LARGE BUS CONFIGURATIONS

Configure three SEL-487B Relays on a per-phase basis for large system bus protection. This configuration offers six three-phase zones of protection, a three-phase check zone, 63 current inputs capable of protecting up to 21 three-phase terminals, and voltage inputs for additional security. With six three-phase zones of protection, an internal fault would remove a minimal number of terminals from service for a complex system. Breaker failure detection is available for each terminal. A three-relay configuration is ideal if you plan to expand the busbar in the near future.



DISTRIBUTED BUS PROTECTION

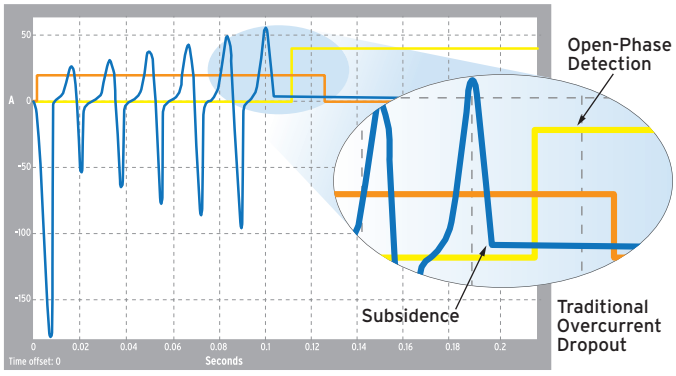
Build a simplified distributed bus solution using Time-Domain Link (TiDL®) technology and a compatible SEL-400 series relay. In a TiDL system, the remote TiDL nodes are located in the yard next to primary equipment and act as field modules. They digitize analog signals and transport the data over a point-to-point fiber-optic cable to the SEL-487B in the control house. TiDL is inherently cybersecure and is easy to implement, with no external time source or network engineering required.



DYNAMIC ZONE SWITCHING

Apply dynamic zone switching with the SEL-487B for extra security at busbars with regular disconnect switching. When interbus ties and disconnects change position, the relay will automatically reassign the current inputs to the proper bus zone. In this bus protection application, the disconnects are open and two three-phase bus zones are present. When the disconnects and tie breaker close, only a single three-phase bus zone is needed. When enabled, the SEL-487B will automatically track which current terminals belong to which bus zone based on the disconnect switch position.

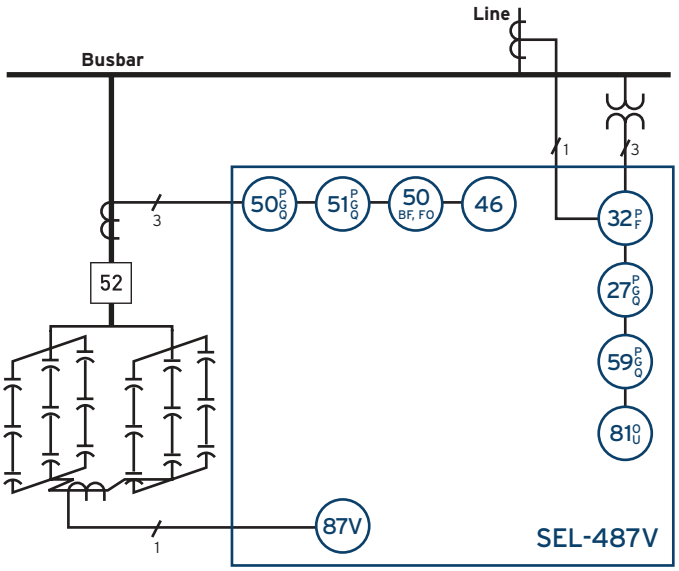
BREAKER APPLICATIONS



BREAKER FAILURE DETECTION

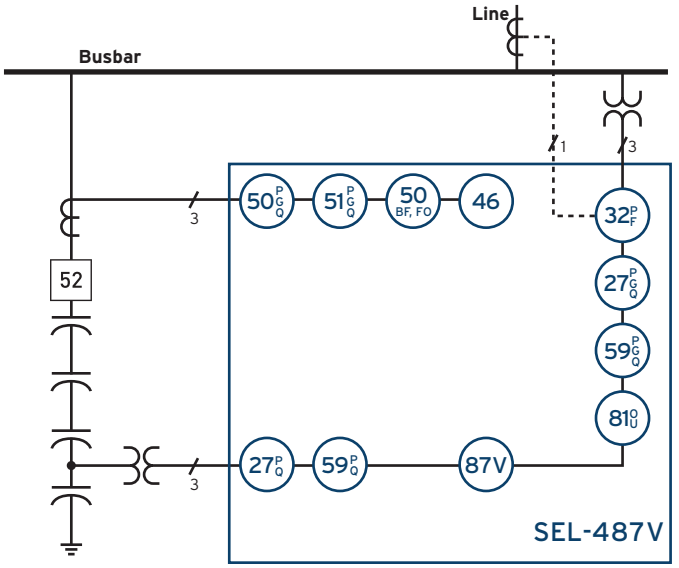
Minimize system clearing times and equipment damage with integrated breaker failure protection and monitoring. Breaker failure detection comes standard with many SEL relays, either with built-in settings or user-implemented SELOGIC® control equations. The built-in breaker failure detection function uses innovative subsidence detection logic to recognize an open-breaker condition by inspection of the ac current waveform. High-speed, open-pole detection logic detects open-pole conditions in fewer than 0.75 cycles to reduce breaker failure coordination times.

CAPACITOR BANK APPLICATIONS



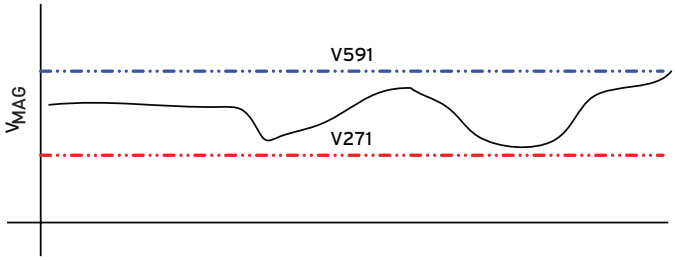
UNGROUNDED CAPACITOR BANKS

Provide protection for many ungrounded capacitor bank configurations with voltage unbalance, neutral current unbalance, and phase current unbalance elements. For example, with ungrounded wye shunt capacitor banks that have neutral current unbalance measurement (shown in the graphic), you can apply neutral current unbalance elements with automatic compensation adjustment. This eliminates any unbalance current caused by capacitor unit manufacturing tolerances or measurement tolerances. RMS or fundamental voltage elements and overcurrent elements provide backup protection.



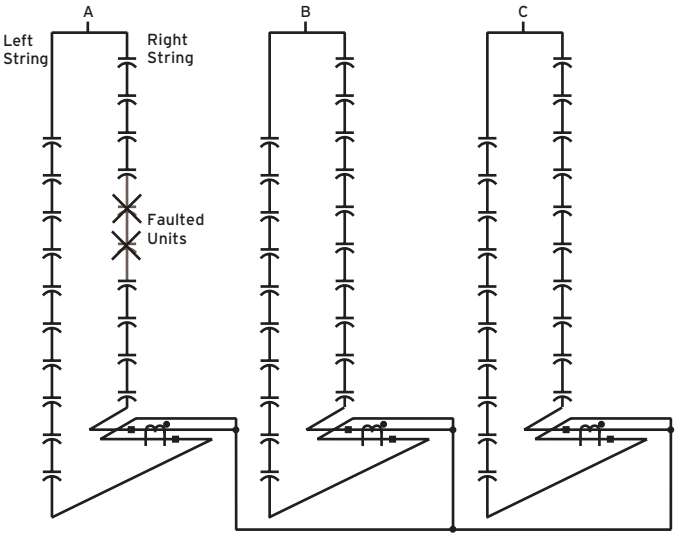
GROUNDED CAPACITOR BANKS

Protect grounded capacitor banks, including wye, double-wye, and H-bank configurations, with the SEL-487V Capacitor Protection and Control System. The relay's directional overcurrent, voltage unbalance, current unbalance, and voltage differential capabilities offer protection for an assortment of applications. Voltage differential protection provides responsive and efficient protection for applications with a large number of capacitor units where regular unbalance protection may not be sensitive enough to detect faults.



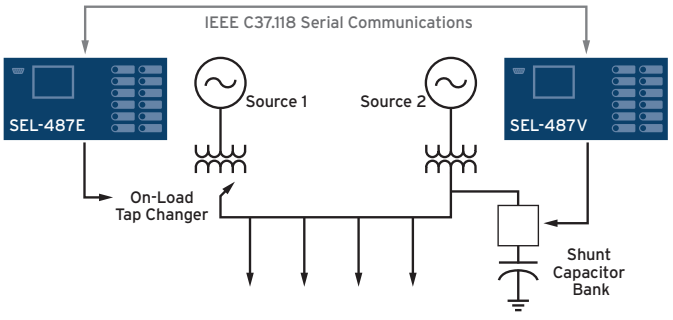
CAPACITOR BANK CONTROL

Control your capacitor banks without wiring and installing additional devices. The SEL-487V-1 has deadband control to keep the system voltage, VAR, or power factor within limits of your choosing. Or, for applications where the reactive power load varies predictably, you can use time-of-day or day-of-week scheduling to switch units in and out. Universal sequencing logic provides flexibility for switching multistaged banks based on the accumulated time in service or other specified conditions. To prevent excessive operation and wear, voltage instability logic detects when the relay is switching the units in a hunting fashion and stops operations or raises an alarm until the issue is resolved.



FAULTED-PHASE LOCATION

Assist crews in finding the faulted capacitor unit by using the patented faulted-phase and section identification logic in the SEL-487V. The logic works in any protection scheme that uses current unbalance or voltage differential protection. After a fault, the relay will provide indications of which phase the fault occurred on as well as a discrete indication of the location relative to the tap (top/bottom, left/right). This information saves valuable time in finding the fault and getting the unit back in service.



REAL-TIME CONTROL

Enhance system coordination and situational awareness with the IEEE C37.118-compliant synchrophasors and the real-time control system available in SEL-400 series relays (except the SEL-487B). These relays can process up to two sets of remote phasor data over serial communications for use in SELOGIC control equations. This information supports control decisions based on remote and local data. For example, an SEL-487E and SEL-487V can exchange data to coordinate between a transformer and capacitor bank and maintain the system at an optimum voltage profile.

SEL-787-2/-3/-4

TRANSFORMER PROTECTION RELAY

Starting Price
$2,950 USD

selinc.com/products/787-3-4

Select models typically ship in 2 days

The SEL-787 provides protection and monitoring for most two-, three-, and four-winding transformers. It offers advanced automation and flexibility, asset management data, and easy retrofitting of most electromechanical relays. The 5-inch, 800 × 480 color touchscreen display option allows you to directly set, monitor, and control your system from the relay front panel.

The SEL-787-2E/21/2X models offer two-winding differential protection, and the SEL-787-3E/-3S models offer three-winding differential protection. In addition, select model options include comprehensive transformer protection with a single-phase restricted earth fault (REF) input or a single-phase voltage input. The SEL-787-4X provides current-based, four-winding differential protection.

Differential Protection—Select the SEL-787 for standard dual-slope differential protection with harmonic blocking and restraint for as many as four terminals. The SEL-787 offers as many as three independent REF elements for sensitive ground-fault detection for grounded-wye transformers. The relay also comes with a variety of overcurrent elements for backup protection, including phase, negative-sequence, residual-ground, and neutral-ground elements. Breaker failure protection for as many as four 3-pole breakers is also standard.

Transformer Monitoring—Measure and track accumulated through-fault current levels, and use optional 4 to 20 mA inputs or resistance temperature detector (RTD) thermal inputs to monitor ambient, load tap changer (LTC) tank, or transformer oil temperatures.

Synchronism Check/Station DC Battery Monitor—Program the VS/VBAT voltage channel in the SEL-787-3S to perform a synchronism check across a circuit breaker or to monitor dc voltage levels of the substation battery.

Metering and Reporting—Eliminate separately mounted metering devices with the built-in metering functions. You can analyze Sequential Events Recorder (SER) reports and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics. The unsolicited SER protocol allows station-wide collection of binary SER messages.

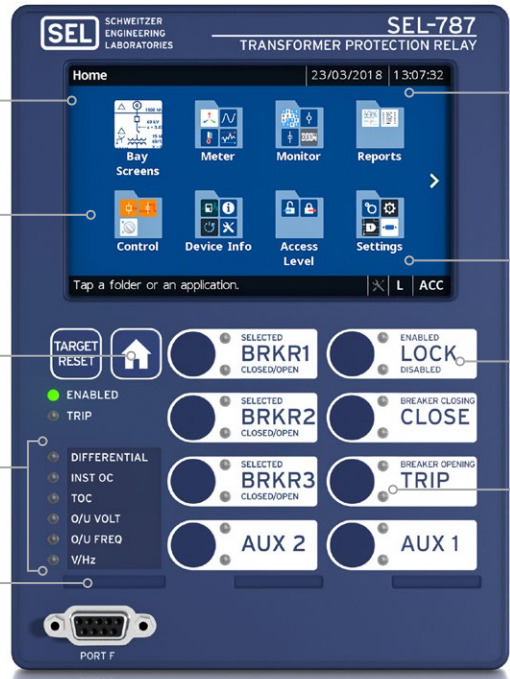
The 5-inch, 800 × 480 color touchscreen display offers direct navigation via a capacitive touchscreen.

Full keyboard facilitates easy adjustment of settings.

The home pushbutton allows you to easily return to the default home screen.

Programmable front-panel tricolor LEDs.

User-configurable label kit.



Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.

Customizable pushbuttons and labels.

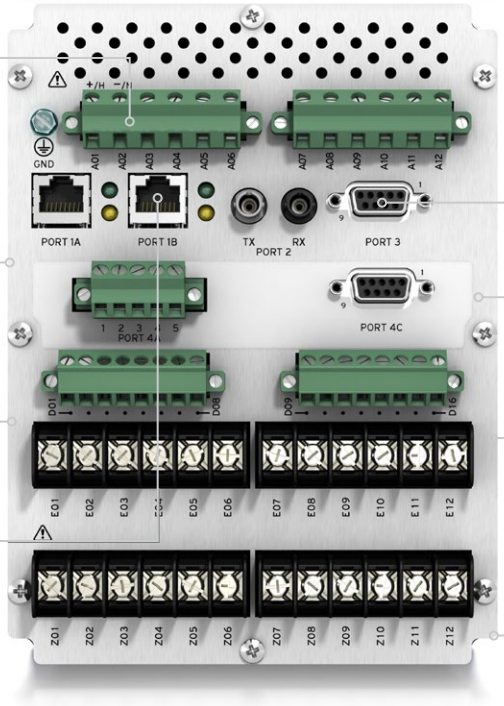
Two programmable tricolor LEDs per pushbutton.

24—48 Vdc, 125—250 Vdc, or 120—240 Vac power supply.

A wide variety of communications protocols and media for flexibility to communicate with other devices and control systems.

Positions for optional I/O cards (listed below).

An integrated web server enables direct relay access for metering and monitoring data.



2 digital inputs (DI) and 3 digital outputs (DO).

EIA-232 serial port (P3) and fiber-optic EIA-232 serial port (P2) with IRIG-B input.

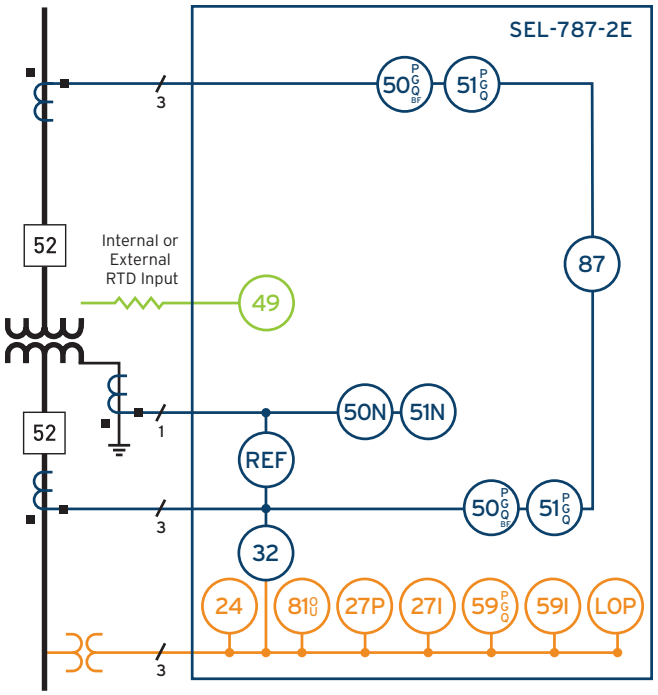
Mirrored Bits communications, IEC 60870-5-103, DNP3, or Modbus protocol (available on multiple ports).

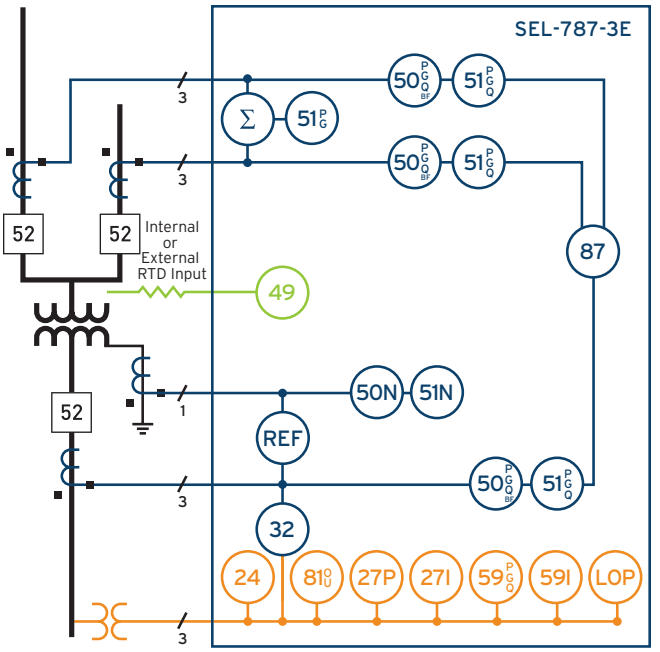
Positions for current and voltage options (listed below).

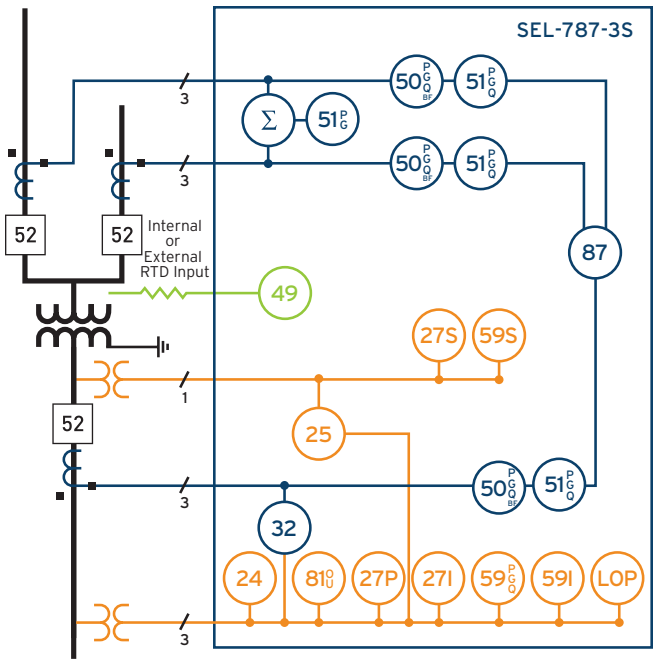
CURRENT AND VOLTAGE INPUT CARDS	MODEL
6 currents (Slot Z)	SEL-787-2X
6 currents (Slot Z) and 1 neutral current (Slot E)	SEL-787-21
6 currents (Slot Z) and 1 neutral current, 3 voltages (Slot E)	SEL-787-2E
6 currents (Slot Z) and 3 currents, 1 neutral current, 3 voltages (Slot E)	SEL-787-3E
6 currents (Slot Z) and 3 currents, 3 voltages, 1 voltage (battery or synchronism check) (Slot E)	SEL-787-3S
6 currents (Slot Z) and 6 currents (Slot E)	SEL-787-4X

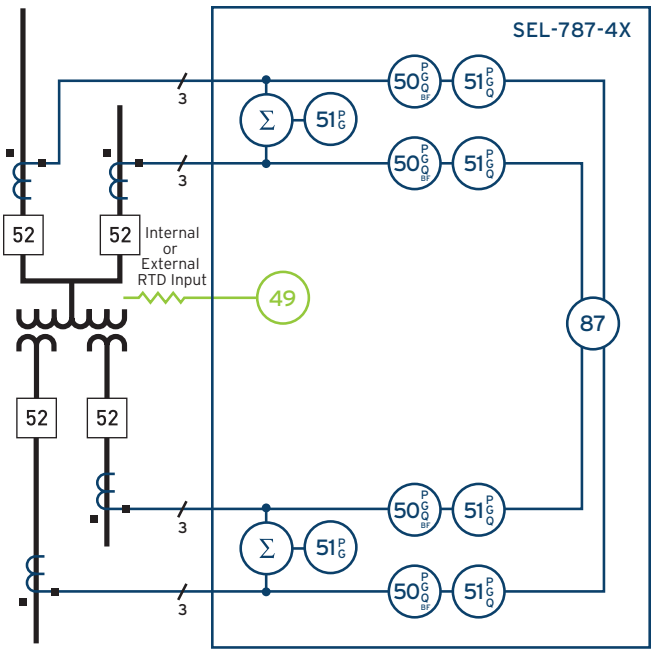
OPTIONAL COMMUNICATIONS AND I/O CARDS
Serial communications card (EIA-232/-485)
3 DI/4 DO/1 4—20 mA analog output (AO)
4 DI/4 DO
8 DO
8 DI
14 DI
4 DI/3 DO (2 Form C, 1 Form B)
4 analog inputs (AI)/4 AO
10 RTD input

SEL-787-2/-3/-4 MODEL FEATURES









		SEL-787-2X	SEL-787-21	SEL-787-2E	SEL-787-3E	SEL-787-3S	SEL-787-4X
WINDINGS							
Windings Protected		2	2	2	3	3	4
CT/PT INPUTS							
Phase Voltage Inputs		0	0	3	3	3	0
Differential Current Inputs		6	6	6	9	9	12
Neutral Current		0	1	1	1	0	0
VS/VBAT Channel		0	0	0	0	1	0
PROTECTION ELEMENTS							
24	Volts/Hertz			•	•	•	
25	Synchronism Check					•	
27I	Inverse-Time Undervoltage (Phase, Phase-to-Phase, Sequential, Vsync)			•	•	•	
27P	Undervoltage (Phase) With Inverse Characteristic			•	•	•	
27PP	Phase-to-Phase Undervoltage			•	•	•	
27S	VS Channel Undervoltage					•	
32	Directional Power			•	•	•	
49	RTDs	•	•	•	•	•	•
50N	Neutral Overcurrent		•	•	•		
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)	•	•	•	•	•	•
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)	•	•	•	•	•	•
51N	Neutral Time Overcurrent		•	•	•		
51PC	Combined Winding Phase Time Overcurrent				•	•	•
51GC	Combined Winding Ground Time Overcurrent				•	•	•
59 (P,G,Q)	Overvoltage (Phase, Ground, Negative Sequence)			•	•	•	
59I	Inverse Time, Overvoltage (Phase, Phase-to-Phase, Sequential, Vsync)			•	•	•	
59S	Overvoltage (Synchronism or Battery Voltage)					•	
81 (O,U)	Over-/Underfrequency			•	•	•	
87	Phase Differential	•	•	•	•	•	•

		SEL-787-2X	SEL-787-21	SEL-787-2E	SEL-787-3E	SEL-787-3S	SEL-787-4X
DIFFERENTIAL AND REF ELEMENTS							
Differential Protection Windings (Standard)		2	2	2	3	3	4
REF Elements (Standard)		0	1	1	1	0	0
Differential Protection Windings (Winding 3 Configured for REF)					2	2	3
REF Elements (Winding 3 Configured for REF)					2	2	2
ADDITIONAL FUNCTIONS							
85RIO	SEL Mirrored Bits Communications	•	•	•	•	•	•
BF	Breaker Failure	•	•	•	•	•	•
BW	Breaker Wear Monitoring	•	•	•	•	•	•
DFR	Event Reports	•	•	•	•	•	•
ENV	SEL-2600 RTD Module*	•	•	•	•	•	•
LDP	Load Data Profiling	•	•	•	•	•	•
LGC	SELogic® Control Equations	•	•	•	•	•	•
LOP	Loss of Potential			•	•	•	
MET	High-Accuracy Metering	•	•	•	•	•	•
RTD	10 Internal or 12 External (see ENV) RTD Inputs*	•	•	•	•	•	•
REF	Restricted Earth Fault		•	•	•	•	•
RTU	Remote Terminal Unit	•	•	•	•	•	•
SER	Sequential Events Recorder	•	•	•	•	•	•
TFE	Through-Fault Event Monitor	•	•	•	•	•	•
PMU	Synchronized Phasor Measurement	•	•	•	•	•	•

*Optional feature

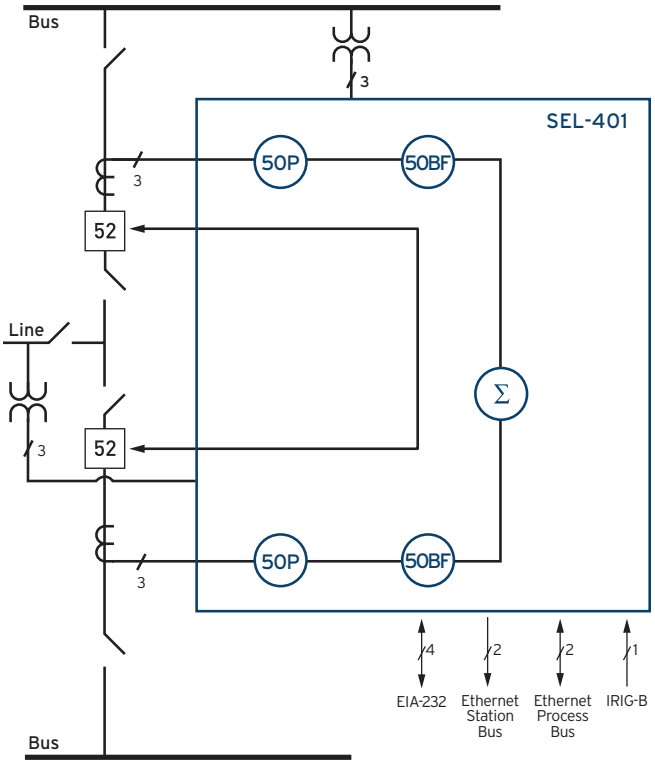
SEL-401

PROTECTION, AUTOMATION, AND CONTROL MERGING UNIT

Starting Price
$5,000 USD

selinc.com/products/401

The SEL-401 is a merging unit with built-in overcurrent and breaker failure protection. You can apply the SEL-401 in substations with IEC 61850-9-2 Sampled Values (SV) systems to sample analog data, such as currents and voltages, then publish those data to a fiber-based Ethernet network for use in other IEDs, such as SEL-400 series relays with SV capability. The SEL-401 publishes up to seven SV data streams to the process bus network, where data are synchronized using IEEE 1588 Precision Time Protocol Version 2 (PTPv2) or an IRIG-B time input. The SEL-401 also provides local protection. You can use the built-in phase-overcurrent and breaker failure protection as a backup in case of communications system failures.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
50P	Phase Overcurrent
50BF	Dual Breaker Failure Overcurrent

ADDITIONAL FUNCTIONS	
85 RIO	SEL Mirrored Bits® Communications
BRM	Breaker Wear Monitor
DFR	Event Reports
DNP3	Distributed Network Protocol
HMI	Operator Interface
IEC 61850	Manufacturing Message Specification (MMS), GOOSE, Sampled Values (9-2LE)
LGC	Expanded SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
PTP	IEEE 1588 PTPv2
SBM	Station Battery Monitor
SER	Sequential Events Recorder
SIP	Software-Invertible Polarities

Control and settings are divided into seven relay access levels for increased security. The relay has separate breaker, protection, automation, and output access levels, among others. You can set unique passwords for each access level.

Easy-to-use keypad aids simple navigation and set-point adjustment.

Programmable operator pushbuttons with user-configurable labels offer front-panel customization.

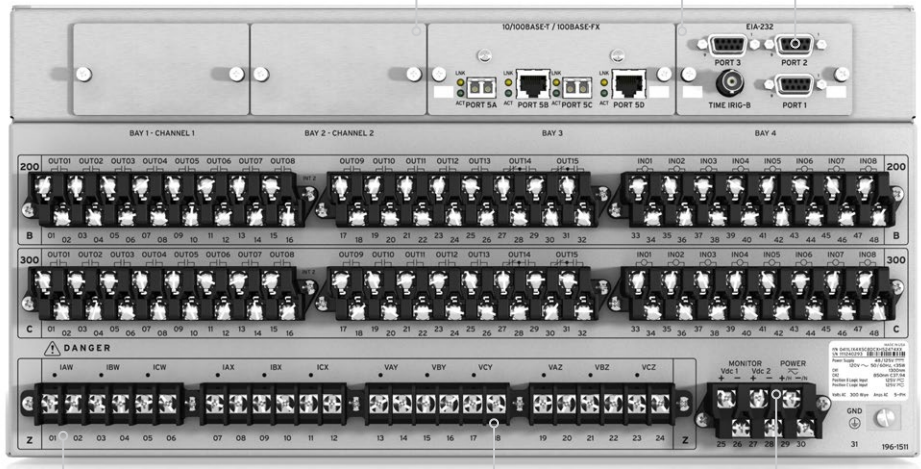
The front-panel display provides status indication and control of as many as ten disconnects. The relay offers control for up to two breakers and provides status indication for up to three breakers.

Up to 24 programmable target LEDs with user-configurable labels alert operators in the substation to faulted phases, the relay's status, and element operation.

User-selectable mimic screens are displayed on the front panel in one-line diagram format. The one-line diagram allows up to six user-configurable labels for disconnect switches, breakers, bay name, and display for up to six analog quantities.

Select fiber-optic, copper, or mixed Ethernet. One pair is reserved for the process bus. The other pair is reserved for the station bus. Ethernet communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), IEEE 1588 PTPv2, IEC 61850-9-2, and IEC 61850 Edition 2.

Three EIA-232 serial ports for MIRRORED BITS communications, SCADA, and engineering access provide flexibility to communicate with other devices and control systems. The ports include demodulated IRIG-B for precise-time input.



Vertical or horizontal, panel-mount or rack-mount hardware package. The size options available are 4U, 5U, or 6U and allow you to order up to three I/O boards (shown as 5U horizontal rack mount with two I/O boards).

Six current and six voltage analog inputs, orderable in standard terminal blocks (shown) or a Connectorized® hardware configuration.

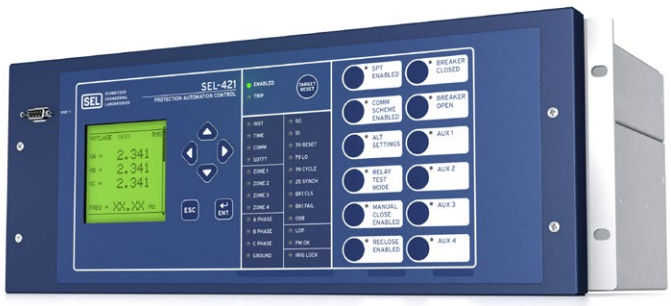
Power supply options include 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

SEL-421-7

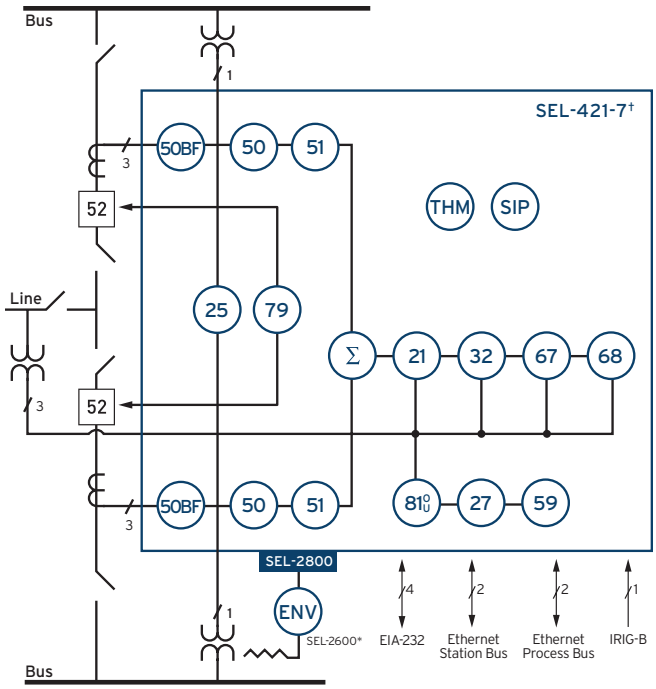
PROTECTION, AUTOMATION, AND CONTROL MERGING UNIT

Starting Price
$9,000 USD

selinc.com/products/421



The SEL-421-7 is a merging unit that combines advanced high-speed transmission line protection with the flexibility of IEC 61850-9-2 Sampled Values (SV) and the UCA 61850-9-2LE guideline. It digitizes analog signals from primary equipment and then publishes as many as seven SV data streams to relays in the control house via an Ethernet network. The data are synchronized using IEEE 1588 Precision Time Protocol Version 2 (PTPv2) or an IRIG-B time input. In the event of lost communications on the IEC 61850 network, the SEL-421-7 can provide standalone protection.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21	Phase and Ground Distance
25	Synchronism Check
27	Undervoltage
32	Directional Power
50	Overcurrent
50BF	Dual Breaker Failure Overcurrent
51	Time Overcurrent
59	Overvoltage
67	Directional Overcurrent
68	Out-of-Step Block/Trip
79	Single-/Three-Pole Frequency
81 (O,U)	Over-/Underfrequency
85 RIO	SEL MIRRORED BITS® Communications
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	Expanded SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDE	Load Encroachment
LOC	Fault Locator
SBM	Station Battery Monitor
SIP	Software-Invertible Polarities
SV	IEC 61850-9-2 Sampled Values Technology*†
THM	IEC 60255-Compliant Thermal Model
TiDL®	Time-Domain Link Technology*

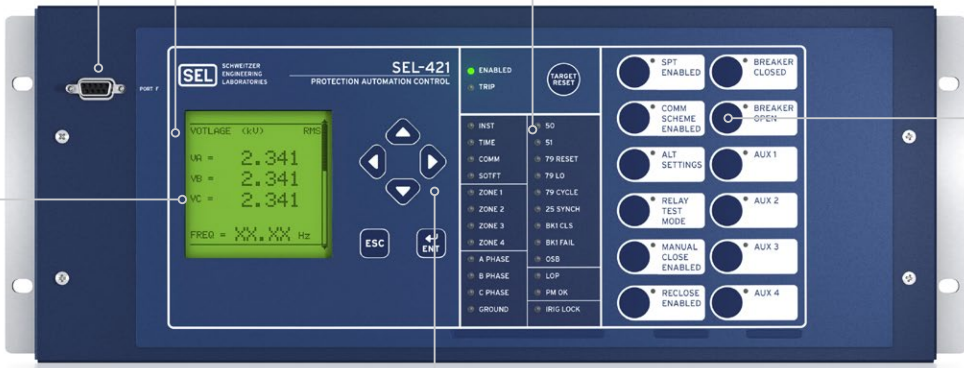
*Optional feature †Copper or fiber-optic

†SV subscriber relays have no analog input boards and instead receive voltages and current through Ethernet.

EIA-232 front serial port is quick and convenient for system setup and local access.

The front-panel display allows operators to control and view the status of disconnects and breakers.

Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.



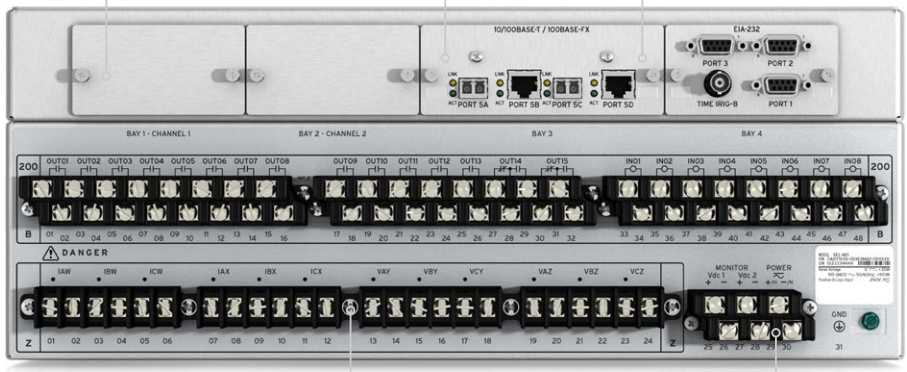
The user-selectable mimic screens show the system configuration in one-line diagram format.

Programmable operator push-buttons with user-configurable labels allow front-panel customization.

Easy-to-use keypad aids simple navigation.

Chassis options (for up to three I/O boards) and mounting options accommodate hardware needs.

Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.



Six current and six voltage analog inputs support signal digitization and local protection schemes.

Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

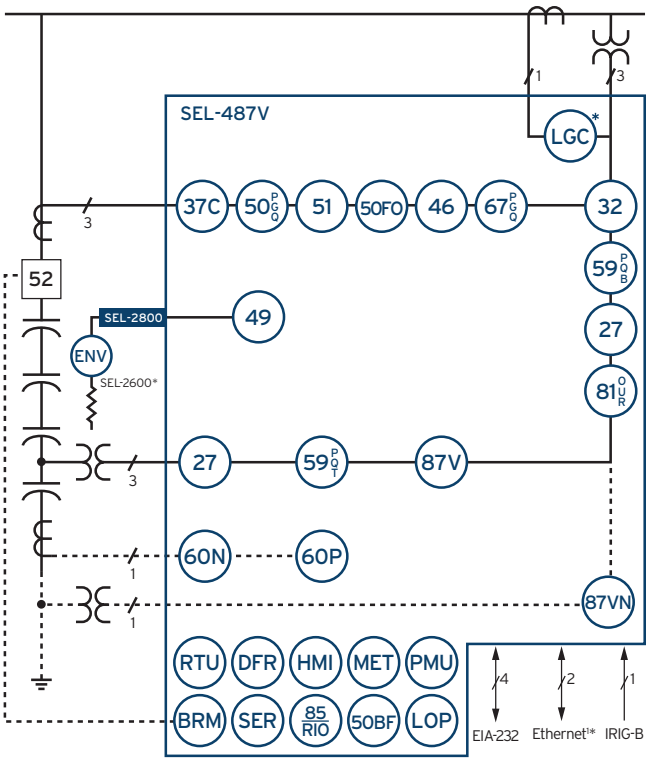
SEL-487V

CAPACITOR PROTECTION AND CONTROL SYSTEM

Starting Price
$4,200 USD

selinc.com/products/487V

Use the SEL-487V for all your capacitor bank needs to simplify relay setting and application while reducing inventory. The versatile SEL-487V can handle grounded and ungrounded, single- and double-wye capacitor bank applications. It provides sensitive voltage differential and current unbalance protection and compensates for small voltage differential variations in individual capacitor elements from manufacturing, PT, or instrument transformer measurement errors. Application-based settings simplify setup and installation while fault-finding logic locates faulty capacitor units to speed up necessary maintenance. Synchrophasor technology provides situational awareness and real-time control.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
27	Undervoltage
32	Real and Reactive Power
37C	Undercurrent
46	Current Unbalance
49	Programmable Thermal Control and Logic
50BF	Breaker Failure Overcurrent
50FO	Flashover Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51	Time Overcurrent (Selectable)
59 (P,Q,B,T)	Overvoltage (Phase, Negative Sequence, Bank, Inverse Time)
60N	Neutral Current Unbalance
60P	Phase Current Unbalance
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Negative Sequence)
81 (O,U,R)	Frequency (Over, Under, Rate)
85 RIO	SEL Mirrored Bits® Communications
87V	Phase Voltage Differential
87VN	Neutral Voltage Differential
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	Capacitor Bank Control*
LOP	Loss of Potential
MET	High-Accuracy Metering
PMU	Synchrophasors
RTU	Remote Terminal Unit
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDP	Load Data Profiling*

*Optional feature

†Copper or fiber-optic

EIA-232 front serial port is convenient for system setup and local access.

Easy-to-use keypad aids simple navigation.

Front-panel LEDs indicate custom alarms and provide information to assist dispatchers and line crews with rapid power restoration.

LCD allows you to control and view the status of disconnects and breakers.

Programmable operator pushbuttons with user-configurable labels allow front-panel customization.

Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), and IEC 61850.

Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.

Use one front and three rear EIA-232 ports for MIRRORED BITS communications, DNP3, SCADA, and engineering access.

Six current and six voltage channels support applications for grounded and ungrounded, single- and double-wye capacitor configurations.

Power supply options include 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

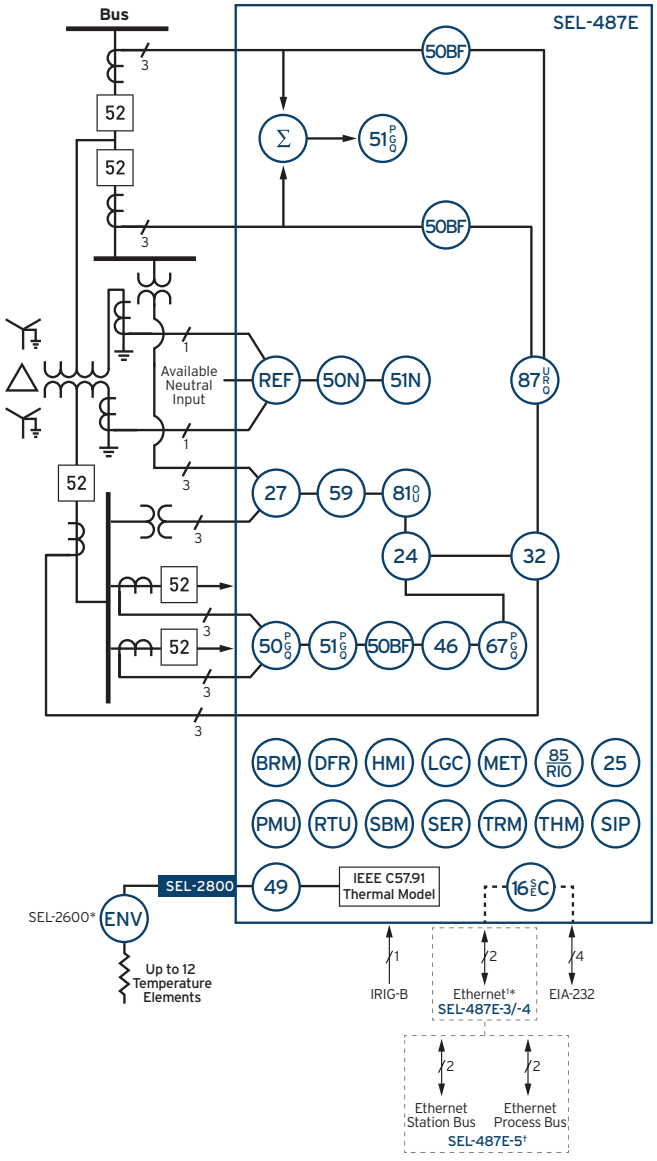
SEL-487E

TRANSFORMER PROTECTION RELAY

Starting Price
$6,750 USD

selinc.com/products/487E

The SEL-487E provides protection and monitoring for most transformer applications. The relay offers up to five three-phase restraint inputs, three independent restricted earth fault (REF) protection elements, and two three-phase voltage inputs, all with synchrophasors. The SEL-487E limits transformer damage by responding to internal fault conditions in less than 1.5 cycles and helps avoid catastrophic transformer failure by detecting turn-to-turn faults involving as little as 2 percent of the total winding. You can minimize commissioning time and eliminate costly errors with SEL software that recommends matrix compensation settings. Through-fault and thermal monitoring allow you to track transformer wear and schedule maintenance as necessary. Breaker wear monitoring reduces inefficient and costly breaker maintenance, saving time and money. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology using IEC 61850-9-2 transform the way you modernize your substation.



ANSI NUMBER/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
24	Volts/Hertz
25	Synchronism Check
27	Undervoltage
32	Directional Power
46	Current Unbalance
49	Thermal
50BF	Breaker Failure Overcurrent
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51N	Neutral Time Overcurrent
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
59	Overvoltage
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Negative Sequence)
81 (O,U)	Over-/Underfrequency
85 RIO	SEL MIRRORED BITS® Communications
87 (U,R,Q)	Transformer Differential (Unrestrained, Restrained, Neg. Seq.)
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	Expanded SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
REF	Restricted Earth Fault
RTU	Remote Terminal Unit
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
LDP	Load Data Profiling
SBM	Station Battery Monitor
SIP	Software-Invertible Polarities
SV	IEC 61850-9-2 Sampled Values Technology*†
THM	IEC 60255-Compliant Thermal Model
TiDL	Time-Domain Link Technology*
TRM	Transformer Monitor

*Optional feature †Copper or fiber-optic

†SV subscriber relays have no analog input boards and instead receive voltages and current through Ethernet.

EIA-232 front serial port is quick and convenient for system setup and local access.

Easy-to-use keypad aids simple navigation.

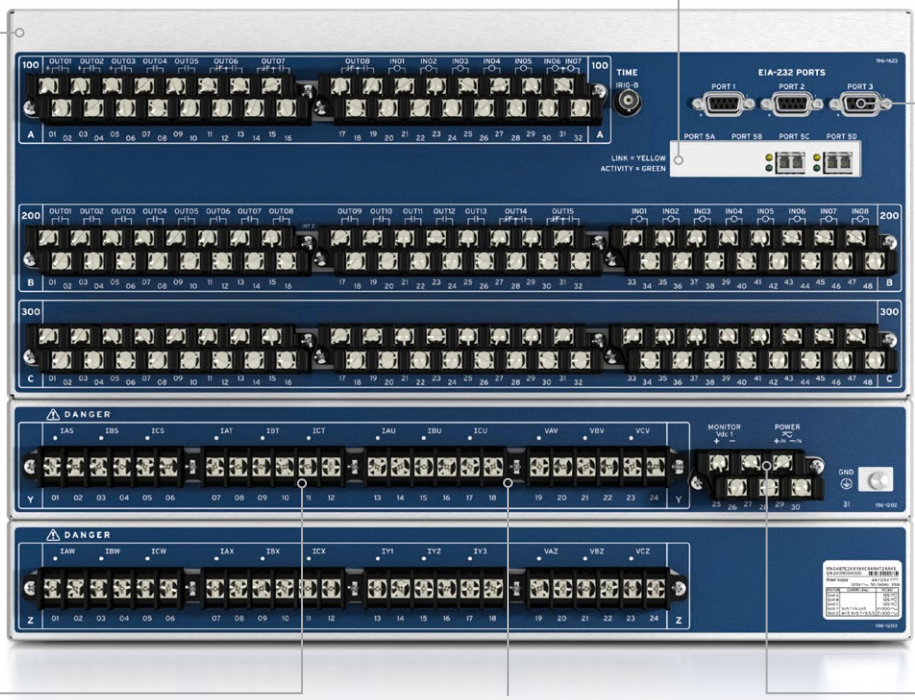
Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.

LCD allows you to control and view the status of disconnects and breakers.

Programmable operator pushbuttons with user-configurable labels allow front-panel customization.

Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.

Choose from a vertical (5U only) or horizontal, panel-mount or rack-mount chassis and different size options.



Use one front and three rear EIA-232 ports for MIRRORED BITS communications, DNP3, SCADA, and engineering access.

The 18 current and 6 voltage channels support transformer differential protection for up to 5 three-phase terminals, 3 independent REF elements, and voltage elements.

Connectorized® hardware configuration or a Euro connector with low-energy analog (LEA) voltage inputs provide flexibility for different line voltage sensors or optical voltage transformers.

Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

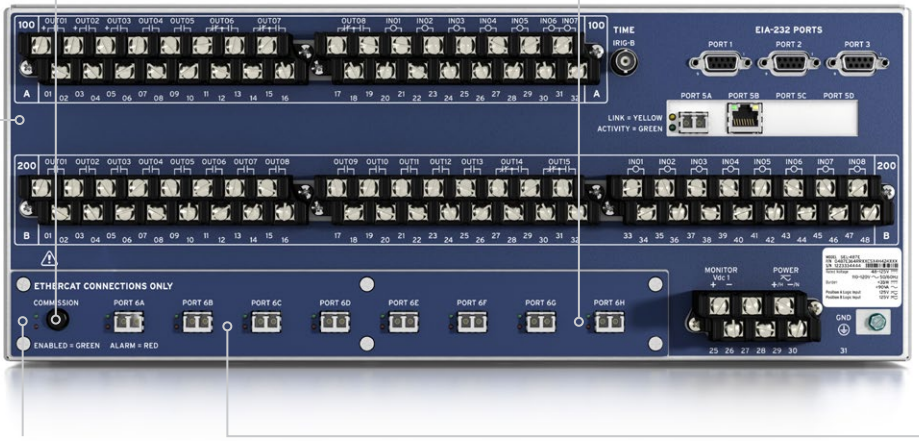
**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.

SEL-487E OVERVIEW—TIDL OPTION

Commission button usage prompts the relay to communicate with the remote TiDL nodes.

LEDs indicate the connection status to a remote TiDL node on a per-port basis.

4U chassis with horizontal mounting options (panel or rack) accommodates your application needs.



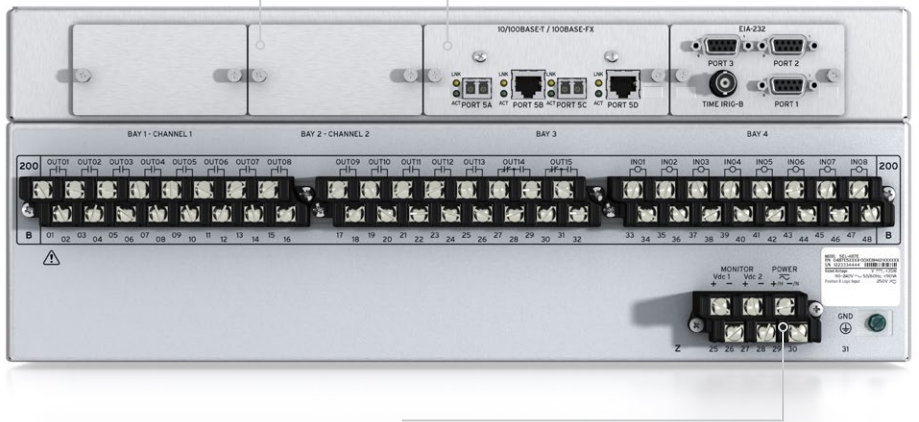
LEDs indicate a valid configuration and successful commissioning.

Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote TiDL nodes and to receive remote analog and digital data.

SEL-487E OVERVIEW—SV OPTION

The 4U chassis has various mounting options to accommodate hardware needs.

Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.



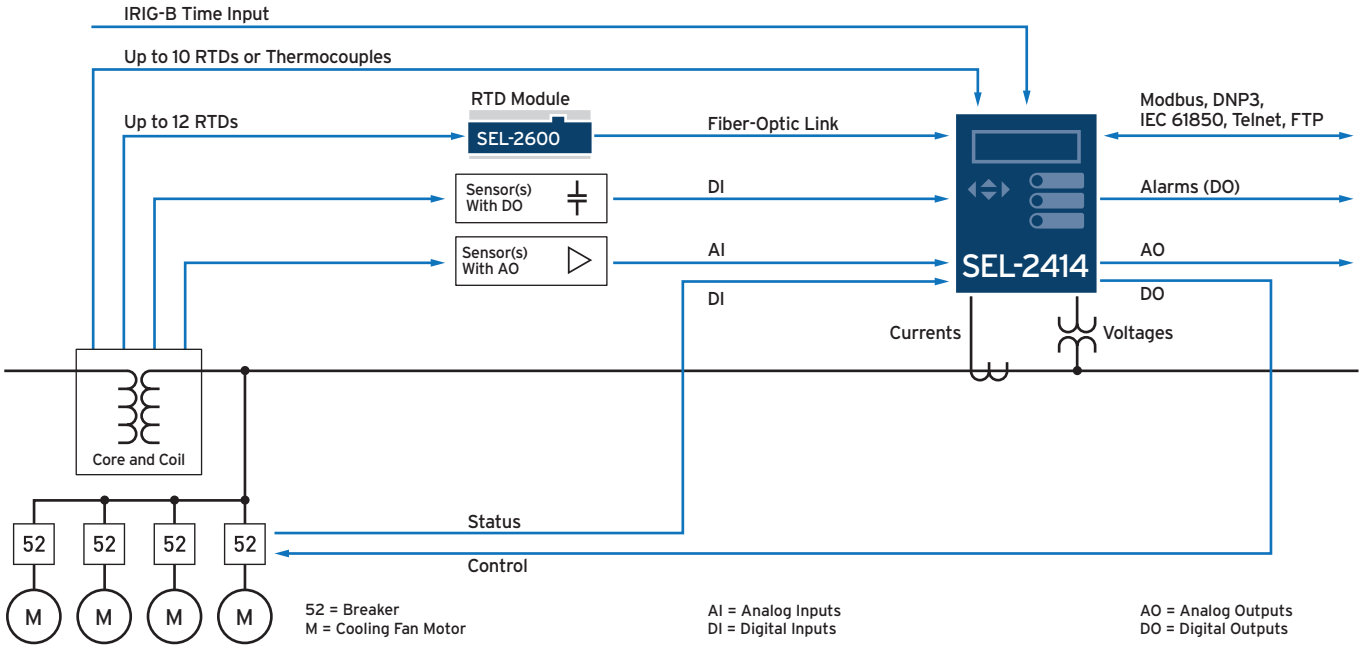
Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

SEL-2414
TRANSFORMER MONITOR

Starting Price
$1,150 USD

selinc.com/products/2414

The SEL-2414 provides standalone or distributed monitoring and control of transformers. With flexible communications options, it can connect to a SCADA or automation system. Multiple I/O options are available to help you monitor your system, from detecting oil levels and sudden pressure to alerting alarm systems or control functions. The SEL-2414 withstands harsh physical and electrical environments and is built and tested to meet mission-critical IEEE and IEC protective relay standards.



Input diagram for typical transformer monitoring, cooling, and control applications.

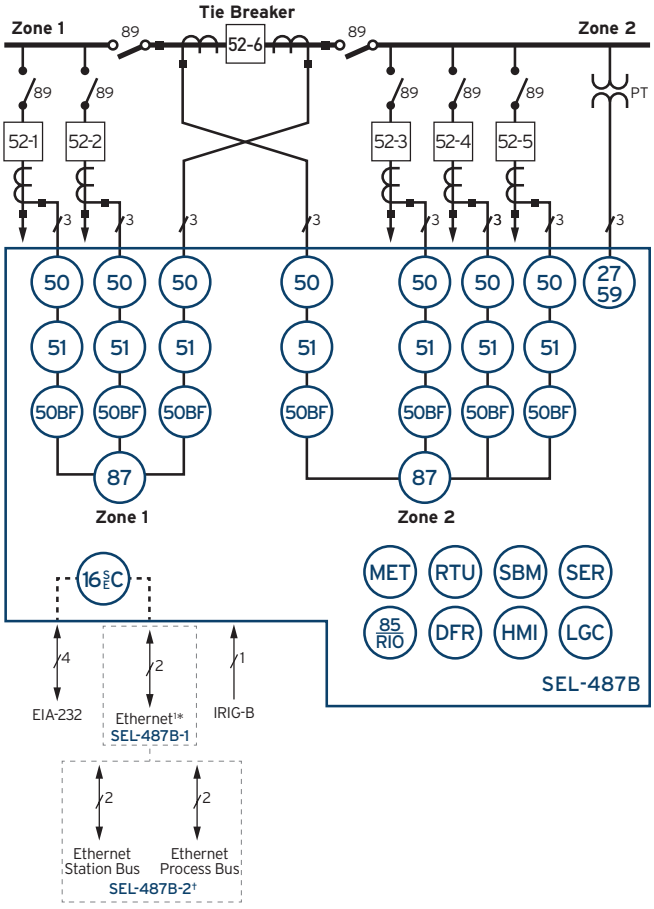
SEL-487B

BUS DIFFERENTIAL AND BREAKER FAILURE RELAY

Starting Price
$6,830 USD

selinc.com/products/487B

The SEL-487B provides optimized, low-impedance bus differential fault detection by using high-speed, subcycle protection coupled with high-security operation for external faults. Superior protection performance and integrated station automation features provide a seamless solution for new and retrofit applications. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology transform the way you modernize your substation. A distributed bus protection scheme using TiDL is easily scalable based on the number of bays in your system and does not require special communications ports or network engineering. The TiDL architecture simplifies fiber-optic cable routing in the field and makes the commissioning process quick and easy.



ANSI NUMBER/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
27/59	Over-/Undervoltage
50	Overcurrent
50BF	Breaker Failure Overcurrent
51	Time Overcurrent
85 RIO	SEL MIRRORED BITS® Communications
87	Current Differential
DFR	Event Reports
HMI	Operator Interface
LGC	Expanded SELOGIC® Control Equations
MET	High-Accuracy Metering
RTU	Remote Terminal Unit
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
SBM	Station Battery Monitor
SV	IEC 61850-9-2 Sampled Values Technology*†
TiDL	Time-Domain Link Technology*

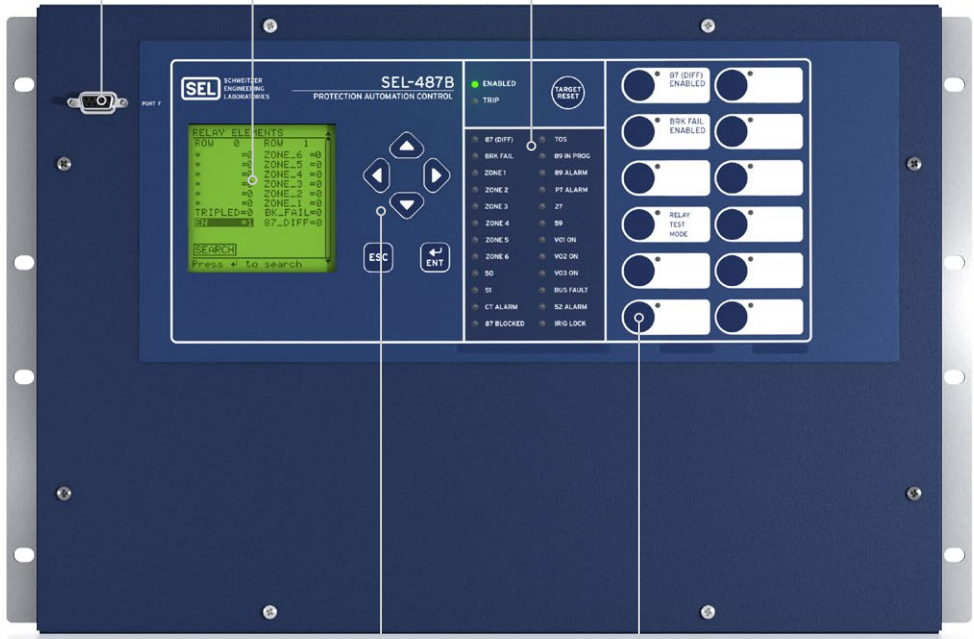
*Optional feature †Copper or fiber-optic

†SV subscriber relays have no analog input boards and instead receive voltages and current through Ethernet.

EIA-232 front serial port is quick and convenient for system setup and local access.

LCD automatically scrolls between custom displays.

Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.

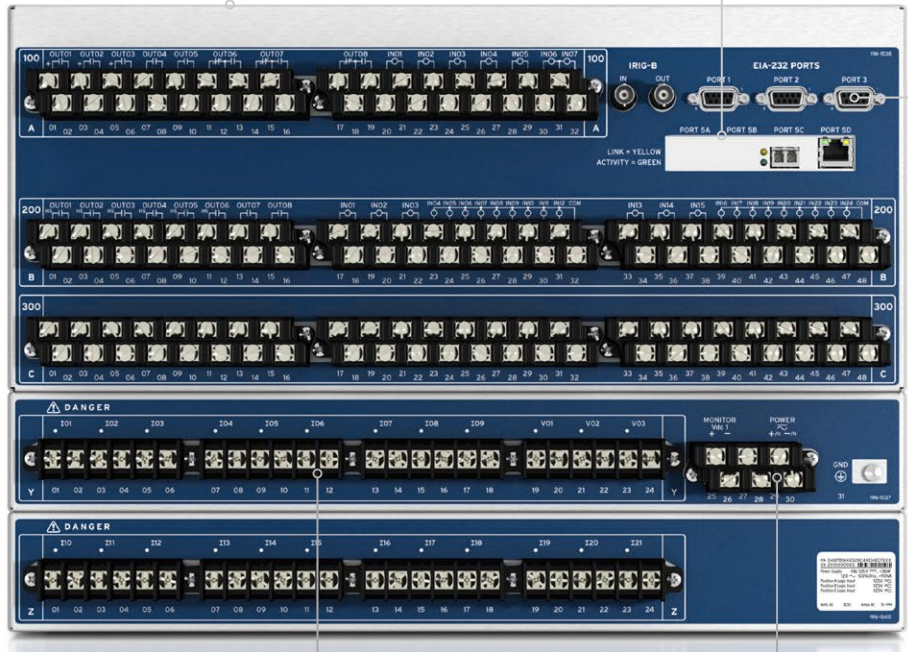


Easy-to-use keypad aids simple navigation.

Programmable operator pushbuttons with user-configurable labels allow for front-panel customization.

Choose from a horizontal panel-mount or rack-mount chassis and different size options.

Communications protocols include FTP, Telnet, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.



Use one front and three rear EIA-232 ports for MIRRORED BITS communications, DNP3, SCADA, and engineering access.

21 current and 3 voltage channels accommodate different busbar configurations.

Choose from power supply options such as 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.

SEL-487B OVERVIEW—TIDL OPTION

Commission button usage prompts the relay to communicate with the remote TiDL nodes.

LEDs indicate the connection status to a remote TiDL node on a per-port basis.

4U chassis with horizontal mounting options (panel or rack) accommodates your application needs.

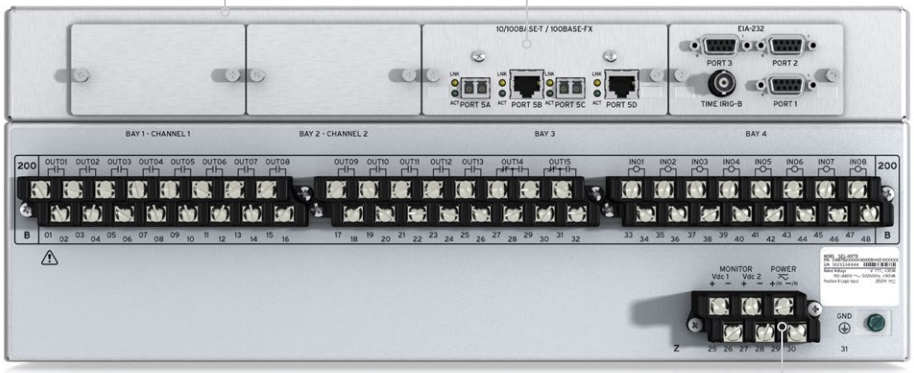
LEDs indicate a valid configuration and successful commissioning.

Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote TiDL nodes and to receive remote analog and digital data over the network.

SEL-487B OVERVIEW—SV OPTION

The 4U chassis has various mounting options to accommodate hardware needs.

Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.



Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

SEL-387/387A

CURRENT DIFFERENTIAL AND OVERCURRENT RELAYS

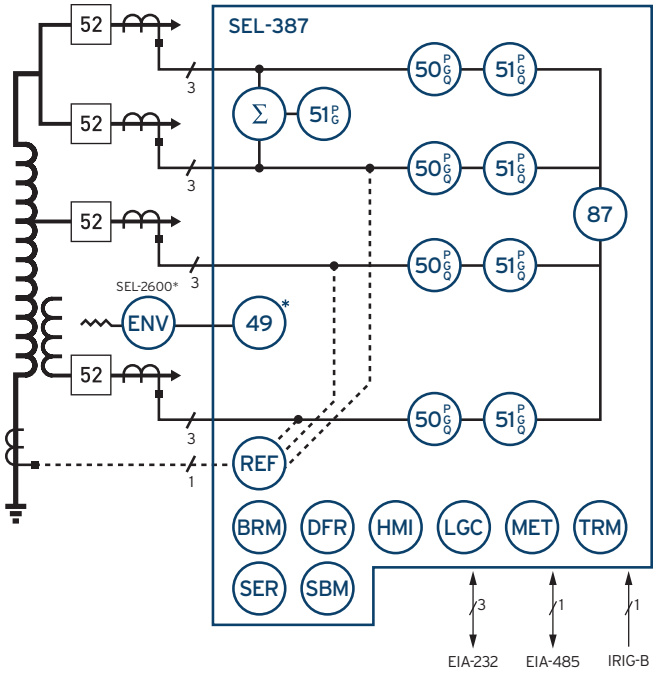
Starting Price

SEL-387: $5,250 USD

SEL-387A: $3,680 USD

selinc.com/products/387 or selinc.com/products/387A

The SEL-387 provides protection, control, and metering for transformers, buses, breakers, and feeders. Features include four three-phase current inputs with independent restrained and unrestrained differential protection, programmable single- or dual-slope differential characteristics, a circuit breaker monitor, a battery voltage monitor, and enhanced SELOGIC® control equations. The SEL-387A offers restrained and unrestrained differential protection for two terminals. Second-, fourth-, and fifth-harmonic elements, enhanced by the dc element, provide security during transformer energization and overexcitation conditions in a user-defined choice of either harmonic restraint or harmonic blocking. Overcurrent elements provide backup protection that contributes to the versatility of the SEL-387A.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
49	Thermal Monitoring*
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
87	Current Differential
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	SELOGIC Control Equations
MET	High-Accuracy Metering
REF	Restricted Earth Fault
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
SBM	Station Battery Monitor
TRM	Transformer Monitor

*Optional feature

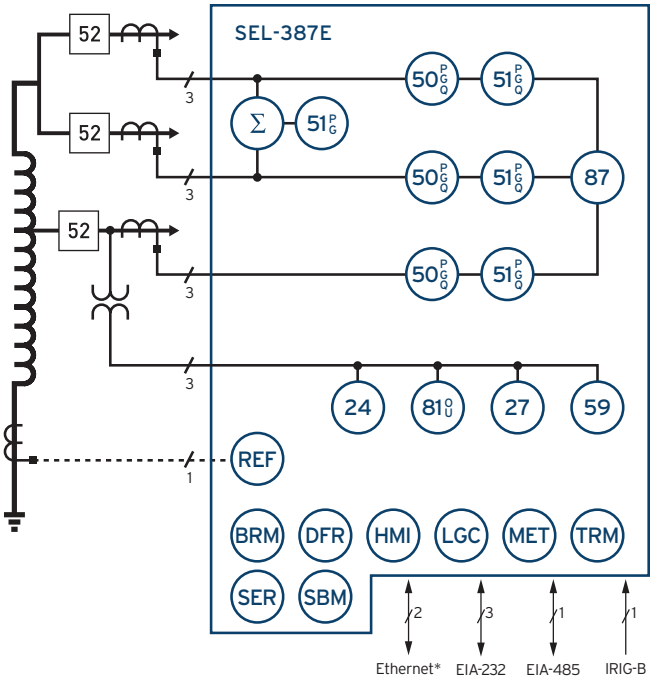
SEL-387E

CURRENT DIFFERENTIAL AND VOLTAGE RELAY

Starting Price
$5,780 USD

selinc.com/products/387E

The SEL-387E protects two- or three-winding power transformers. Voltage inputs for power metering, overexcitation protection, and over-/underfrequency load shedding provide versatile solutions for power system equipment protection. Automation features reduce total project construction and operation costs through elimination of traditional external control switches, meters, and indicating lamps.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
24	Volts/Hertz
27	Undervoltage
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
59	Overvoltage
81 (O,U)	Over-/Underfrequency
87	Current Differential
DFR	Event Reports
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
REF	Restricted Earth Fault
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
SBM	Station Battery Monitor
TRM	Transformer Monitor

*Optional feature

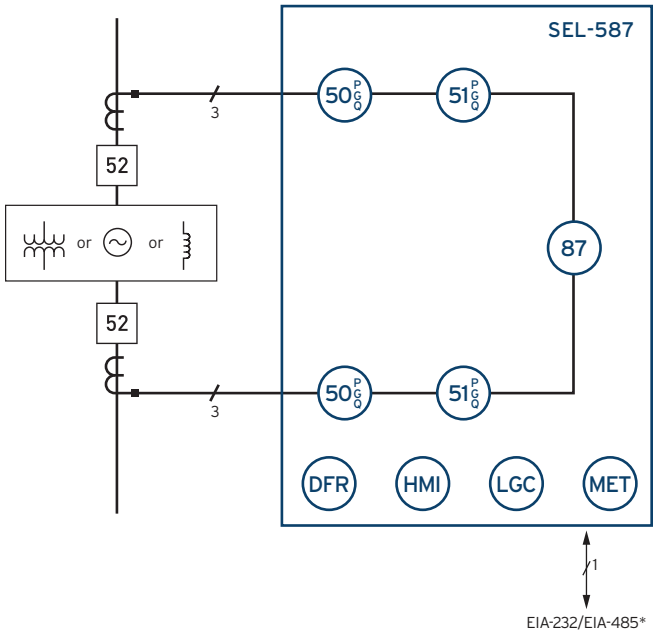
SEL-587

CURRENT DIFFERENTIAL RELAY

Starting Price
$2,080 USD

selinc.com/products/587

The SEL-587 provides current differential protection with programmable single- or dual-slope percentage restraint for two-winding transformers, reactors, generators, large motors, and other two-terminal equipment. You can expand beyond basic transformer protection by applying individual winding phase, ground, and negative-sequence overcurrent elements. The SEL-587 also provides event reports for quick post-event analysis.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
87	Current Differential
DFR	Event Reports
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering

*Optional feature

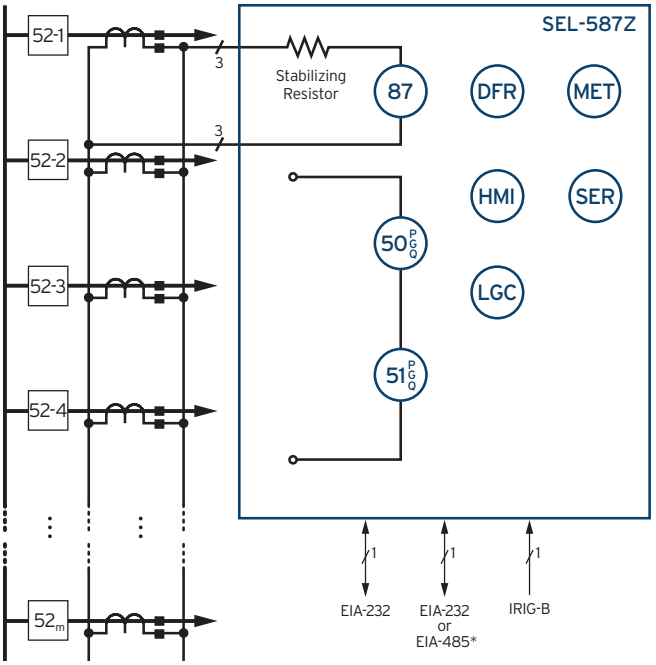
SEL-587Z

HIGH-IMPEDANCE DIFFERENTIAL RELAY

Starting Price
$3,940 USD

selinc.com/products/587Z
Select models typically ship in 2 days

The SEL-587Z is an economical and flexible relay that combines proven high-impedance analog technology with the advantages of microprocessor technology. Designed primarily for high-impedance bus protection, the relay is also suitable for restricted earth fault applications on transformers with grounded-wye windings. The high-impedance differential elements provide fast tripping for in-zone faults while offering security during heavy through faults and CT saturation. The relay includes the resistors and metal-oxide varistors (MOVs) required for high-impedance differential protection. You can use the independent overcurrent elements to complement the high-impedance differential elements. Event reports and the Sequential Events Recorder (SER) simplify post-event analysis.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
87	Three-Phase High-Impedance Differential Elements
DFR	Event Reports
LGC	SELOGIC® Control Equations
HMI	Operator Interface
MET	High-Accuracy Metering
SER	Sequential Events Recorder

*Optional feature

SEL-352

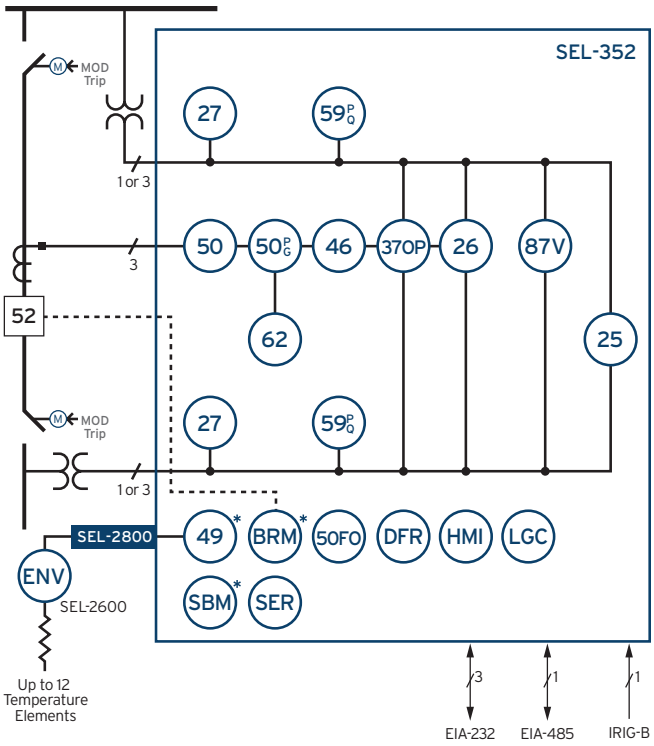
BREAKER FAILURE RELAY

Starting Price

$3,570 USD

selinc.com/products/352

The SEL-352 provides breaker failure protection, breaker control, and breaker monitoring. A cost-saving data recorder and sophisticated breaker monitor and controller reduce maintenance and supervise manual operations. With flexible SELOGIC® control equations, you can use the SEL-352 for a variety of applications.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
25	Synchronism Check
26	Insertion Resistor Thermal
27	Undervoltage
37OP	Breaker Overpower
46	Current Unbalance
49	Thermal*
50	RMS Overcurrent
50FO	Flashover Overcurrent
50 (P,G)	Overcurrent (Phase, Ground)
59 (P,Q)	Overvoltage (Phase, Negative Sequence)
62	Breaker Failure Timer
87V	Voltage Differential
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HMI	Operator Interface
LGC	SELOGIC Control Equations
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor*
SBM	Station Battery Monitor*

*Optional feature

DISTRIBUTION PROTECTION OVERVIEW

SEL-751

Ideal for industrial and utility feeder protection, offering an intuitive color touchscreen, fast and secure arc-flash detection, flexible I/O, and advanced communications.

SEL-451

Flexible overcurrent protection with complete substation bay control.

SEL-351

Transmission or distribution overcurrent protection, monitoring, and control.

SEL-351A

An economical solution for distribution feeder protection.

SEL-351S

Comprehensive feeder and overcurrent protection perfect for industrial and utility feeder applications.

SEL-501

Two complete and independent groups of protection in one low-cost unit for feeders, buses, transformers, motors, and breakers.

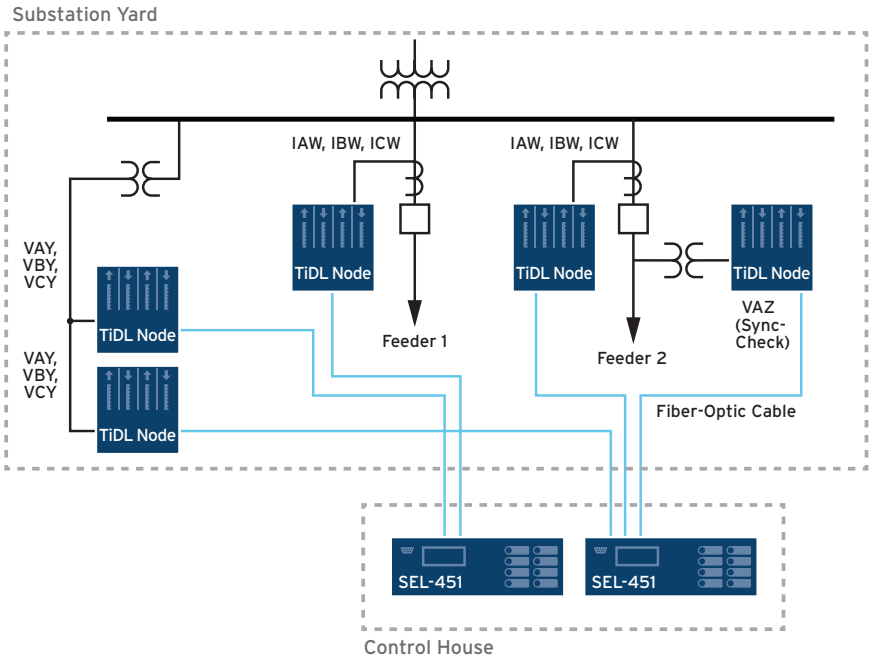
SEL-551/551C

Distribution protection and control in new and retrofit installations.

	SEL-451	SEL-351	SEL-351A	SEL-351S	SEL-751	SEL-751A	SEL-501/501-2	SEL-551/551C
APPLICATIONS								
Distribution Feeder Protection	•	•	•	•	•	•	•	•
Breaker Failure Protection	•	•	ƒ	•	•	•	+	ƒ
Generator Intertie Protection	•	•	•	•	+	+		
Synchronism Check	•	•	•	•	+	+		
Underfrequency Load Shedding	ƒ	•	•	•	•	•		
Undervoltage Load Shedding	ƒ	•	•	•	•	+		
PROTECTION								
27/59 Under-/Overvoltage	•	•	•	•	•	+		
32 Directional Power Elements	ƒ	+		+	•	+		
49 IEC Line/Cable Thermal Overload	ƒ				•			
50 (P,N,G,Q) Overcurrent Element (Phase, Neutral, Ground, Negative Sequence)	•	•	•	•	•	•	•	•
51 (P,N,G,Q) Time Overcurrent Element (Phase, Neutral, Ground, Negative Sequence)	•	•	•	•	•	•	•	•
67 (P,N,Q) Directional Overcurrent (Phase, Neutral, Negative Sequence)	•	•	•	•	+			
78VS Vector Shift					•			
81 Over-/Underfrequency	•	•	•	•	•	+		
Separate Neutral Overcurrent	•	•	•	•	•	•		•
Load-Encroachment Supervision	•	•	•	•	•			
Low-Energy Analog (LEA) Voltage Inputs	+				+			
Directional Sensitive Earth Fault Protection		+	+	+	+			
Pilot Protection Logic	•	•		•				
Rate-of-Change of Frequency (df/dt)	•	•	•	•	•	+		
Harmonic Blocking	•	•	+	•	•			
Arc Sense™ Technology (AST) High-Impedance Fault Detection	+				+			
Arc-Flash Detection					+	+		
Phantom Phase Voltage		•	•	•				
Current/Voltage Channels	6/6	4/4	4/4	4/4	4/3 4/5+	4/0 4/5+	6/0	4/0
Complete Two-Breaker Control	•						•	
INSTRUMENTATION AND CONTROL								
79 Automatic Reclosing	•	•	•	•	+	+		•
Fault Locating	•	•	•	•	•			
SELOGIC® Control Equations With Remote Control Switches	•	•	•	•	•	•		•
SELOGIC Counters	•				•	•		
Voltage Check on Closing	•	•	•	•	+	+		
SELOGIC Nonvolatile Latch	•	•	•	•	•	•		+
Nonvolatile Local Control Switches	•	•	+	•	•	•		•
Substation Battery Monitor	•	•	•	•	+	+		
Breaker/Recloser Wear Monitor	•	•	•	•	•	•		
Trip Coil Monitor	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ		ƒ
Voltage Sag, Swell, and Interruption (VSSI)	•	+		+				
Load/Signal Profile Recorder	•	+		+	•	•		
Sequential Events Recorder	•	•	•	•	•	•		•
Software-Invertible Polarities	•							
IEC 60255-Compliant Thermal Model	•							
DNP3 Level 2 Outstation	•	•	•	•	+	+		
Parallel Redundancy Protocol (PRP)	+	•	•	•	+			
IEEE 1588 Precision Time Protocol Version 2 (PTPv2)	+							
Time-Domain Link (TiDL®) Technology	+							
IEEE C37.118 Synchrophasors	•	•	•	•	•	•		
Bay Control	•				+			
Ethernet	+	•	•	•	+	+		
IEC 61850	+	+	+	+	+	+		
IEC 61850 Edition 2	+				+			
IEC 61850-9-2 Sampled Values Technology	+							
Simple Network Time Protocol (SNTP)	•	•	•	•	+	+		
Harmonic Metering		•	•	•				
RMS Metering	•	•	•	•	•	•		

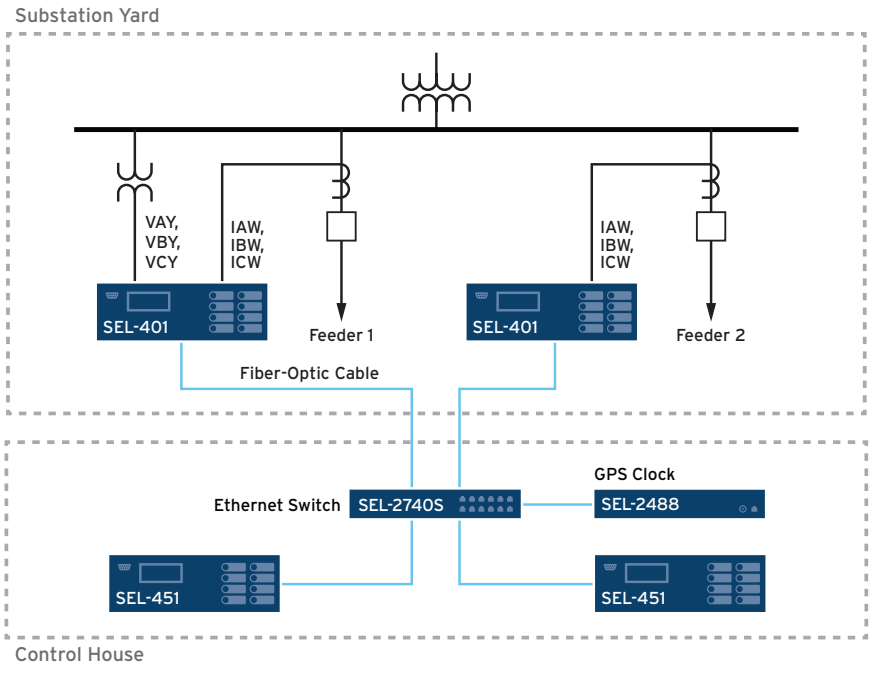
• Standard feature + Model option ƒ May be created using settings

DISTRIBUTION PROTECTION APPLICATIONS



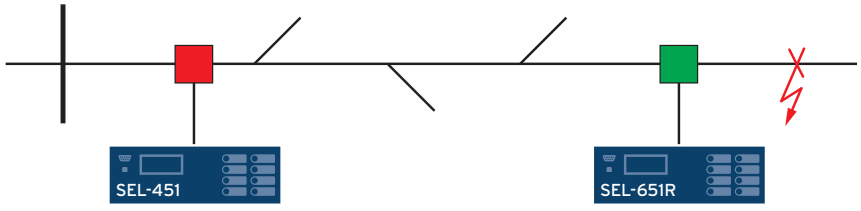
TIME-DOMAIN LINK (TIDL®) TECHNOLOGY

TiDL is a simple and innovative digital secondary system solution that is easy to implement, with no external time source or network engineering required. The TiDL node in the yard provides remote I/O, digitizes analog signals, and sends the signals over fiber-optic cables to the TiDL-enabled SEL-451-5 Protection, Automation, and Bay Control System in the control house.



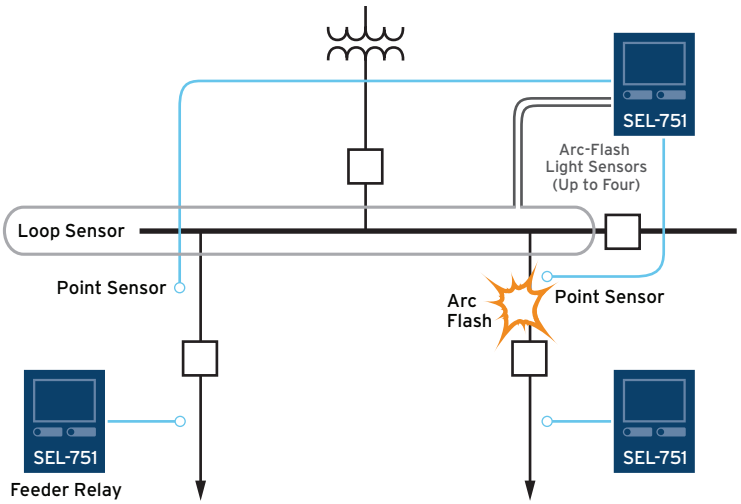
SEL SAMPLED VALUES (SV) TECHNOLOGY

SEL SV combines protection in the merging unit with the flexibility of IEC 61850-9-2. The SEL-451-6 with SEL SV technology receives SV data from SEL merging units or other SV-compliant units via a fiber-based Ethernet network.



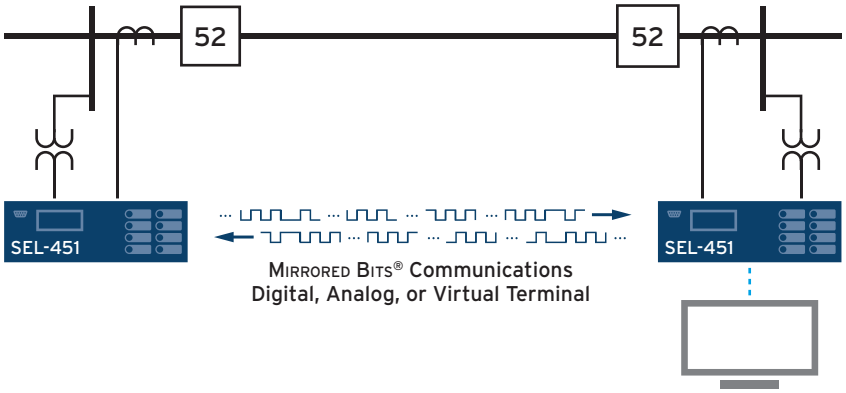
HIGH-IMPEDANCE FAULT DETECTION

Detect high-impedance, arcing faults by using Arc Sense™ technology (AST). SEL relays with AST will send an alarm or trip signal for faults that produce low fault current and are undetectable with conventional overcurrent relays.



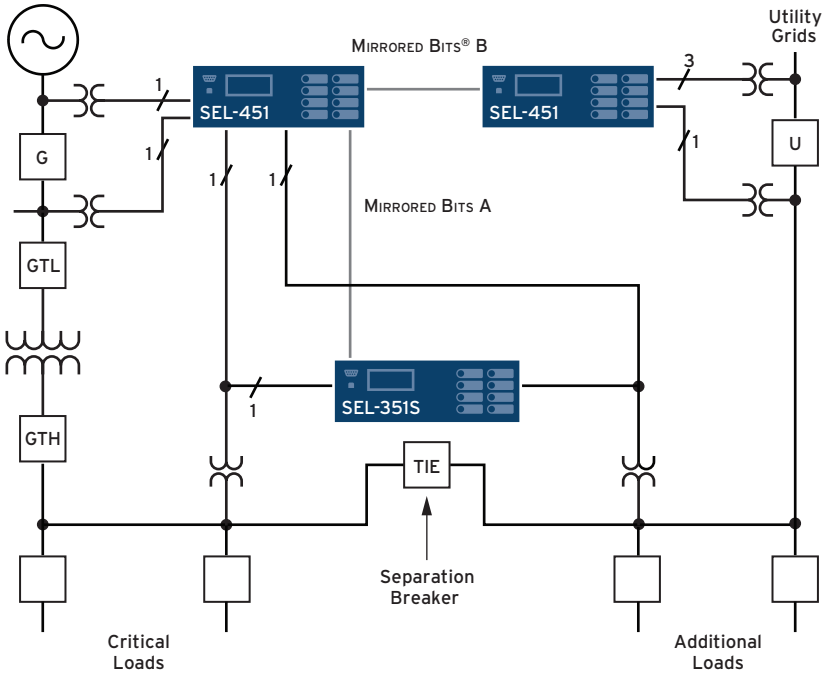
ARC-FLASH MITIGATION

Improve safety and prevent equipment damage with arc-flash detection in the SEL-751 and SEL-751A Feeder Protection Relays. Light-sensing technology combined with fast overcurrent protection provides high-speed arc-flash detection as fast as 2 ms without false tripping. You can choose point sensors, loop sensors, or a combination to protect a wide variety of switchgear configurations.



MIRRORED BITS® COMMUNICATIONS

This field-proven technology provides simple and powerful bidirectional digital communications between devices. MIRRORED BITS communications can transmit/receive information between upstream relays and downstream recloser controls to enhance coordination and generate faster tripping for downstream faults.



AUTOSYNCHRONIZATION

Automatically close the breaker that separates two systems after measuring the voltage and frequency of a generator and the power system. You can send control signals to adjust the governor and exciter as necessary to ensure safe and secure connection of generation.

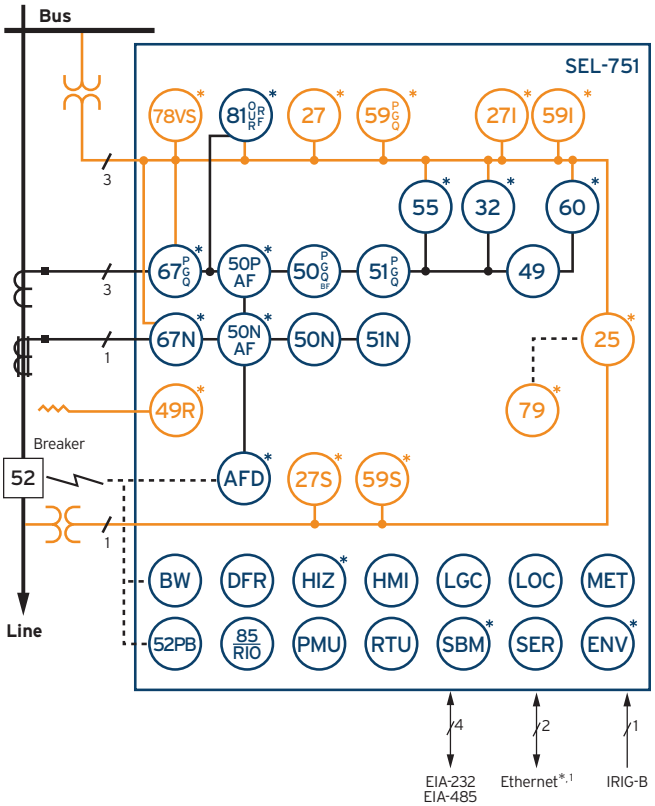
SEL-751

FEEDER PROTECTION RELAY

Starting Price
$950 USD

selinc.com/products/751
Select models typically ship in 2 days

The SEL-751 is ideal for directional overcurrent, fault location, arc-flash detection, incipient-fault detection, and high-impedance fault detection applications. Flexible I/O options, easy mounting, and fast settings make the SEL-751 the right solution for industrial and utility feeder protection. It provides complete feeder protection, with overcurrent, overvoltage, undervoltage, directional power, IEC cable/line thermal, vector shift, sensitive earth fault (SEF), load encroachment, and frequency elements. The 5-inch, 800 × 480 color touchscreen display option lets you directly set, monitor, and control your system. A small form factor and multiple mounting adapters let you easily upgrade protection without cutting or drilling existing cutouts. You can quickly integrate the SEL-751 into serial- or Ethernet-based communications with IEC 61850 Edition 2, IEC 60870-5-103, the IEC 62439 Parallel Redundancy Protocol (PRP), MIRRORED BITS® communications, Modbus, DNP3, Ethernet IP, IEEE 1588 Precision Time Protocol (PTP), and other protocols.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
25	Synchronism Check*
27	Definite-Time Undervoltage*
27I	Phase Undervoltage With Inverse Characteristic*
27S	Synchronism-Check Undervoltage*
32	Directional Power*
49	IEC Cable/Line Thermal
49R	RTD Thermal*
50	Adaptive Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
50BF	Breaker Failure
50N	Neutral Overcurrent
50N AF	Arc-Flash Neutral Overcurrent*
50P AF	Arc-Flash Phase Overcurrent*
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
51N	Neutral Time Overcurrent
52PB	Trip/Close Pushbuttons
55	Power Factor*
59 (P,G,Q)	Definite-Time Overvoltage (Phase, Ground, Neg. Seq.)*
59I	Overvoltage With Inverse Characteristic*
59S	Synchronism-Check Overvoltage*
60	Loss of Potential*
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Neg. Seq.)*
67N	Directional Neutral Overcurrent*
78VS	Vector Shift*
79	Autoreclosing*
81 (O,U,R,RF)	Over-/Underfrequency (Rate, Fast Rate)*

ADDITIONAL FUNCTIONS	
85 RIO	SEL MIRRORED BITS Communications
AFD	Arc-Flash Detector*
BW	Breaker Wear Monitoring
DFR	Event Reports
ENV	SEL-2600 RTD Module*
HIZ	SEL Arc Sense™ Technology (AST)*
HMI	Operator Interface
LDE	Load Encroachment
LDP	Load Data Profiling
LEA	Low-Energy Analog (LEA) for AC Voltage Inputs (8 Vac RMS)
LGC	SELOGIC® Control Equations
LOC	Fault Locator
PMU	Synchrophasors
RTD	10 Internal or 12 External (see ENV) RTD Inputs*
RTU	Remote Terminal Unit
SBM	Station Battery Monitor*
SER	Sequential Events Recorder

*Optional feature [1]Copper or fiber-optic

The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.

The home pushbutton allows you to easily return to the default home screen.

Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases and element operation.

Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.

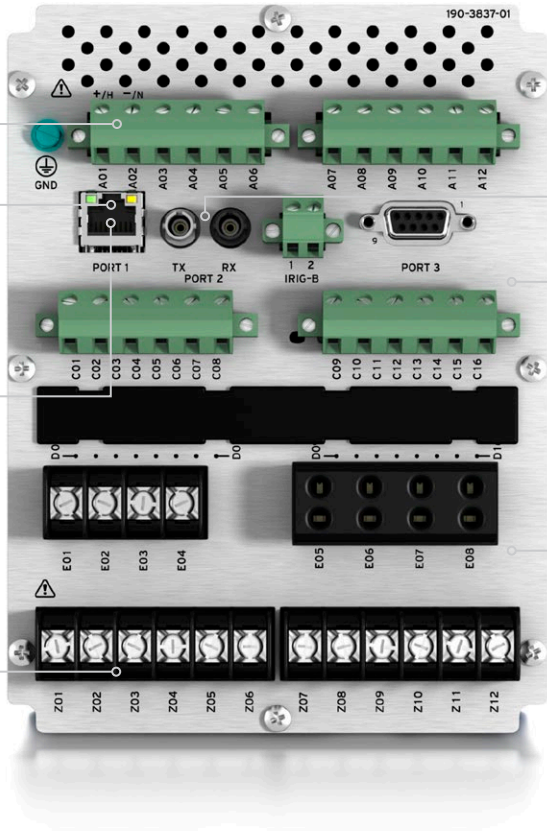
Programmable operator pushbuttons with user-configurable labels allow front-panel customization.

Power supply options include 125—250 Vdc, 120—240 Vac, or 24—48 Vdc.

A variety of communications protocols and media provide flexibility to communicate with other devices and control systems.

Integrated web server enables direct relay access for metering and monitoring data.

Phase current and optional phase voltage inputs are on one card, freeing up space for additional SELECT™ I/O card options.



The optional fiber-optic serial port provides quick and easy engineering access.

Card slots include positions for optional I/O or an arc-flash detection/Vsync/Vbat card.

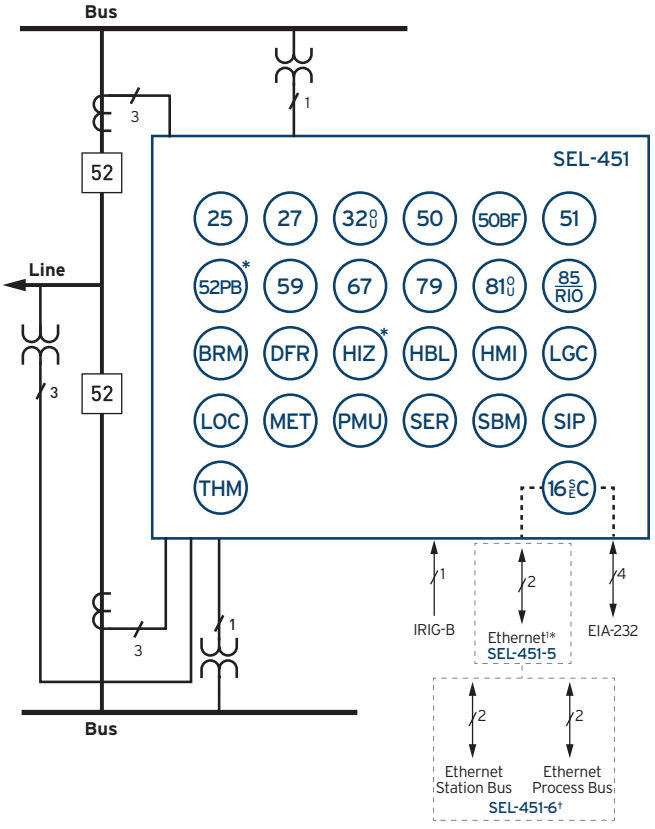
SEL-451

PROTECTION, AUTOMATION, AND BAY CONTROL SYSTEM

Starting Price
$4,200 USD

selinc.com/products/451

The SEL-451 is a standalone system with the speed, power, and flexibility to combine complete substation bay control with high-speed breaker protection in one economical system. You can use the SEL-451 as an integral part of a full substation protection, control, and monitoring solution. It lets you reduce maintenance costs by accurately tracking the breaker operation. Monitoring breaker interruption times and the accumulated breaker duty makes it easy to determine the need for proactive maintenance. Integrating information with SCADA or automation systems is simple through a communications processor or directly via the Ethernet port. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology using IEC 61850-9-2 transform the way you modernize your substation.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
25	Synchronism Check
27	Undervoltage
32 (O,U)	Over- and Underpower
50	RMS Overcurrent
50BF	Dual Breaker Failure Overcurrent
51	Time Overcurrent
52PB	Trip/Close Pushbuttons*
59	Overvoltage
67	Directional Overcurrent
79	Autoreclosing
81 (O,U)	Over-/Underfrequency

ADDITIONAL FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
50G	Best Choice Ground
85 RIO	SEL Mirrored Bits® Communications
BRM	Breaker Wear Monitor
DFR	Event Reports
HBL	Harmonic Blocking
HIZ	High-Impedance Fault Detection With Arc Sense™ Technology*
HMI	Operator Interface
LDE	Load Encroachment
LGC	Expanded SELogic® Control Equations
LOC	Fault Locator
MET	High-Accuracy Metering
PMU	Synchrophasors
SBM	Station Battery Monitor
SER	Sequential Events Recorder
SIP	Software-Invertible Polarities
SV	IEC 61850-9-2 Sampled Values Technology*†
THM	IEC 60255-Compliant Thermal Model
TiDL	Time-Domain Link Technology*

*Optional feature †Copper or fiber-optic

†SV subscriber relays have no analog input boards and instead receive voltages and current through Ethernet.

EIA-232 front serial port is quick and convenient for system setup and local access.

Easy-to-use keypad aids simple navigation.

Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.

Interactive bay display with user-configurable apparatus labels allows the operator to view the status of breakers and disconnect switches and to control them.

Programmable operator pushbuttons with user-configurable labels allow front-panel customization.

Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.

Use a maximum of 68 output contacts.[1]

Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.

Use one front and three rear EIA-232 ports for Mirrored Bits communications, DNP3, SCADA, and engineering access.

Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

Order six current inputs in standard terminal blocks (as shown) or a Connectorized® hardware configuration.

Use a maximum of 103 input contacts.[1]

Choose six voltage inputs in either standard terminal blocks, a Connectorized hardware configuration, or a low-energy analog (LEA) hardware configuration.

[1]Requires 8U chassis

**For PTP implementation, Ports 5A and 5B must be ordered as an option.

SEL-451 OVERVIEW—TIDL OPTION

Commission button usage prompts the relay to communicate with the remote TiDL nodes.

LEDs indicate the connection status to a remote TiDL node on a per-port basis.

4U chassis with mounting options (vertical or horizontal; panel or rack) accommodates your application needs.

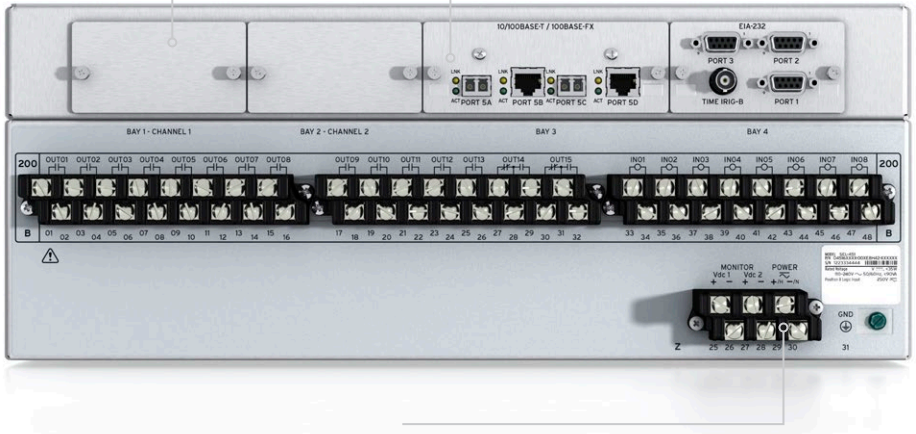
LEDs indicate a valid configuration and successful commissioning.

Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote TiDL nodes and to receive remote analog and digital data.

SEL-451 OVERVIEW—SV OPTION

The 4U chassis has various mounting options to accommodate hardware needs.

Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.



Choose from power supply options such as 24—48 Vdc; 48—125 Vdc or 110—120 Vac; or 125—250 Vdc or 110—240 Vac.

SEL-351
PROTECTION SYSTEM

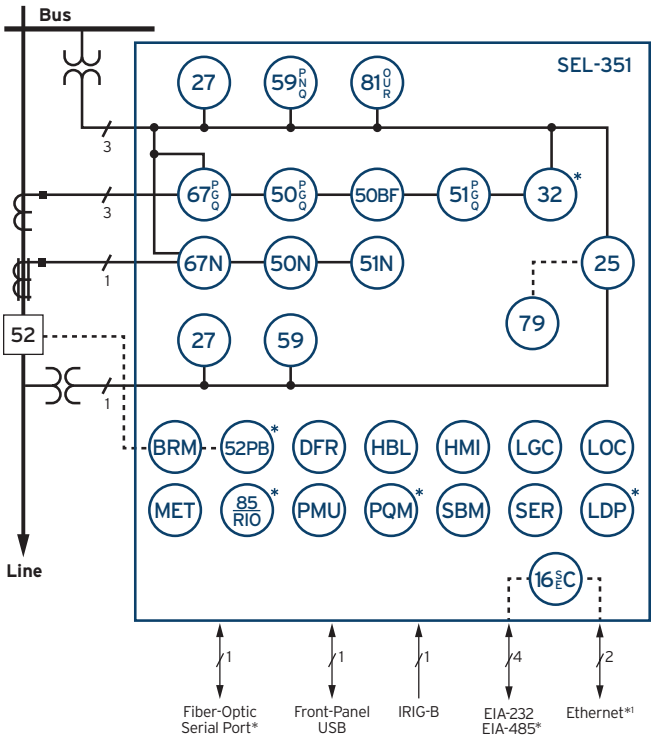
Starting Price

SEL-351-5, -6: $2,480 USD

SEL-351-7: $3,110 USD

selinc.com/products/351

The SEL-351 has built-in Ethernet and IEEE C37.118 synchrophasors and is ideal for directional overcurrent applications. Optional MIRRORED BITS® communications and power quality monitoring add flexibility. The SEL-351 is the protection standard for utility and industrial electrical systems around the world.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
25	Synchronism Check
27	Undervoltage
32	Directional Power*
50BF	Breaker Failure Overcurrent
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51N	Neutral Time Overcurrent
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
52PB	Trip/Close Pushbuttons*
59 (P,N,Q)	Overvoltage (Phase, Neutral, Negative Sequence)
67N	Directional Neutral Overcurrent
67 (P,G,Q)	Directional Overcurrent (Phase; Ground, SEF*; Neg. Seq.)
79	Autoreclosing
81 (O,U,R)	Frequency (Over, Under, Rate)
85 RIO	SEL MIRRORED BITS Communications*
DFR	Event Reports
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
PQM	Voltage Sag, Swell, and Interruption*
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
HBL	Harmonic Blocking
LDE	Load Encroachment
LDP	Load Data Profiling*
LOC	Fault Locator
PPV	Phantom Phase Voltage
SBM	Station Battery Monitor

*Optional feature

[1]Copper or fiber-optic

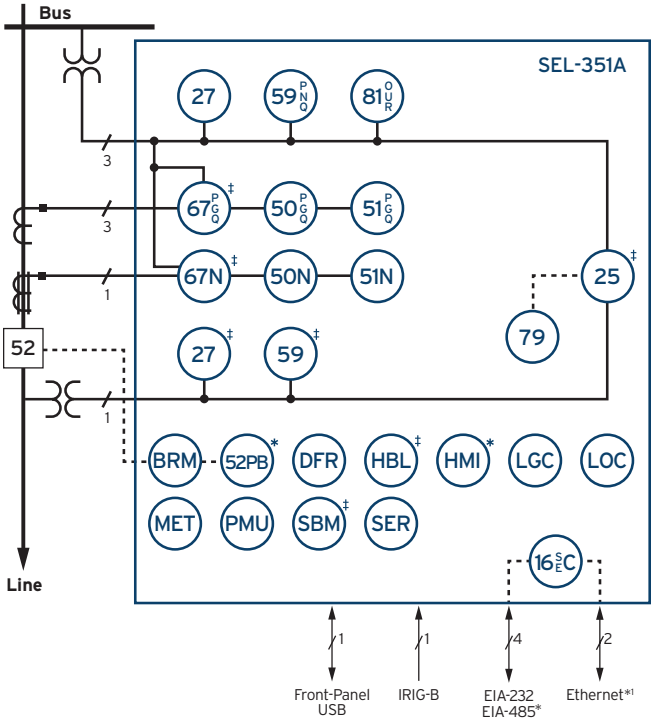
SEL-351A
PROTECTION SYSTEM

Starting Price
SEL-351A-1: $1,360 USD

SEL-351A-0: $1,540 USD

selinc.com/products/351A

The SEL-351A has built-in Ethernet and IEEE C37.118 synchrophasors and is the economical solution for overcurrent protection. Easy-to-use feeder protection and innovative features like SEL's Best Choice Ground Directional Element® logic and SELOGIC® control equations provide superior protection on utility and industrial power systems.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
25	Synchronism Check‡
27	Undervoltage
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground,‡ Negative Sequence)
51N	Neutral Time Overcurrent
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
52PB	Trip/Close Pushbuttons*
59 (P,N,Q)	Overvoltage‡ (Phase, Neutral, Negative Sequence)
67N	Directional Neutral Overcurrent‡
67 (P,G,Q)	Directional Overcurrent (Phase; Ground, SEF*; Neg. Seq.)‡
79	Autoreclosing
81 (O,U,R)	Frequency (Over, Under, Rate)
DFR	Event Reports
HMI	Operator Interface*
LGC	SELOGIC Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
HBL	Harmonic Blocking‡
LDE	Load Encroachment‡
LOC	Fault Locator
PPV	Phantom Phase Voltage
SBM	Station Battery Monitor‡

*Optional feature [1]Copper or fiber-optic

‡Available on the SEL-351A-0

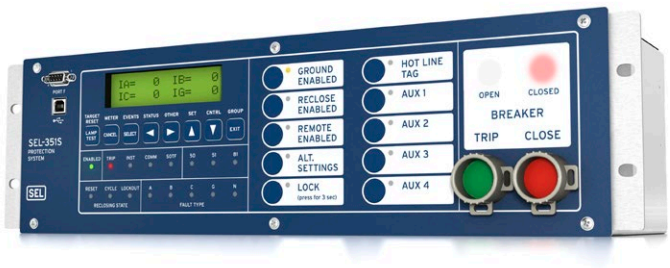
SEL-351S
PROTECTION SYSTEM

Starting Price

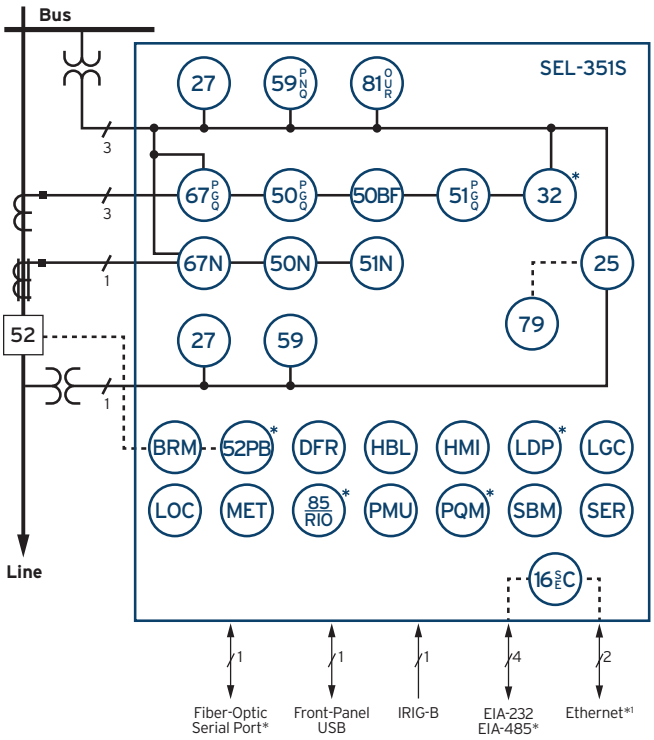
SEL-351S-5, -6: $2,650 USD

SEL-351S-7: $3,280 USD

selinc.com/products/351S



The SEL-351S offers comprehensive feeder and overcurrent protection that is perfect for industrial and utility feeder applications. The relay enhances your quality of service with lower costs and innovative features like Mirrored Bits® communications, IEEE C37.118 synchrophasors, expanded operator controls, and SEL's Best Choice Ground Directional Element® logic.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
25	Synchronism Check
27	Undervoltage
32	Directional Power*
50BF	Breaker Failure Overcurrent
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51N	Neutral Time Overcurrent
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
52PB	Trip/Close Pushbuttons*
59 (P,N,Q)	Overvoltage (Phase, Neutral, Negative Sequence)
67N	Directional Neutral Overcurrent
67 (P,G,Q)	Directional Overcurrent (Phase; Ground, SEF*; Neg. Seq.)
79	Autoreclosing
81 (O,U,R)	Frequency (Over, Under, Rate)
85 RIO	SEL Mirrored Bits Communications*
DFR	Event Reports
HMI	Operator Interface
LGC	SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
PQM	Voltage Sag, Swell, and Interruption*
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
HBL	Harmonic Blocking
LDE	Load Encroachment
LDP	Load Data Profiling*
LOC	Fault Locator
PPV	Phantom Phase Voltage
SBM	Station Battery Monitor

*Optional feature

[1]Copper or fiber-optic

SEL-501/501-2

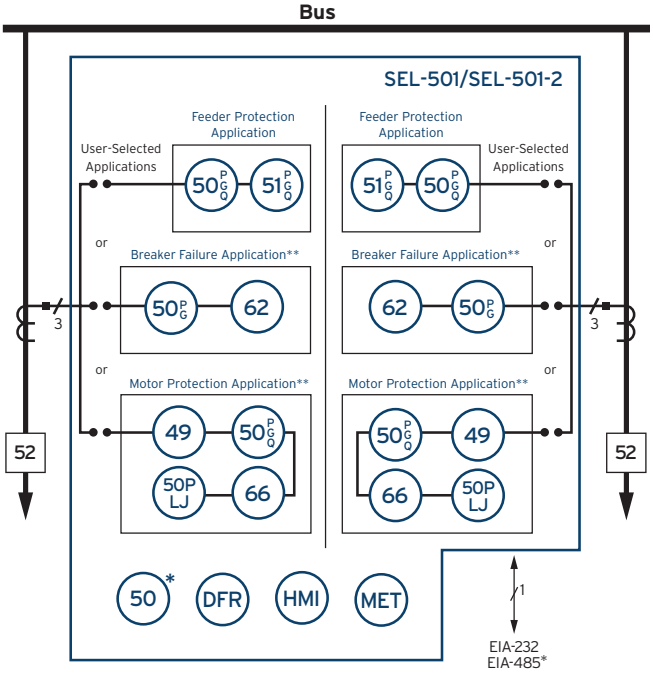
DUAL OVERCURRENT RELAYS

Starting Price
$1,000 USD

selinc.com/products/501

The SEL-501 provides simple and economical protection for transformers, breakers, motors, capacitor banks, feeders, and other apparatus, with two independent three-phase overcurrent relays in a single compact package. The SEL-501-2 is a dual overcurrent relay for feeders, buses, and other apparatus.

Both relays contain Relay X and Relay Y, each having separate optoisolated inputs, output contacts, and three-phase current inputs. They also provide numerous protection schemes with user-enabled settings.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
49	Thermal
50 (P,G)	Overcurrent (Phase, Ground)
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
50P (LJ)	Load Jam/Loss
50	Adaptive Overcurrent*
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
62	Timer
66	Starts Per Hour

ADDITIONAL FUNCTIONS	
DFR	Event Reports
HMI	Operator Interface
MET	High-Accuracy Metering

*Optional feature **Not supported by SEL-501-2

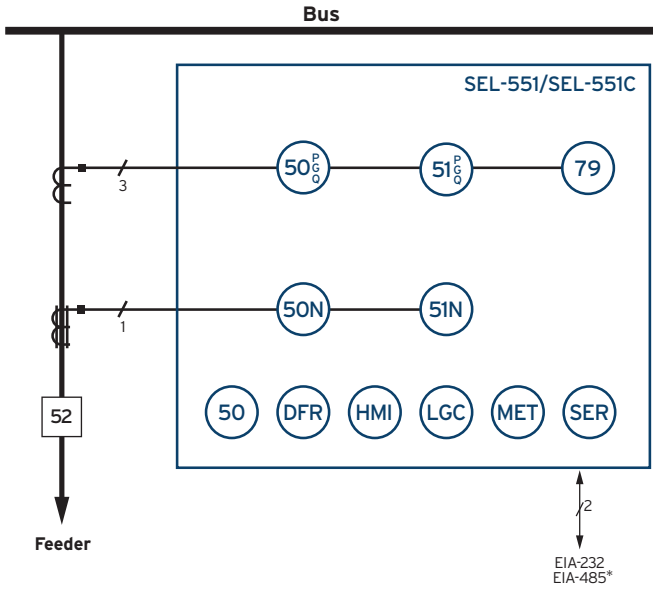
SEL-551/551C

OVERCURRENT/RECLOSING RELAYS

Starting Price
$840 USD

selinc.com/products/551 or selinc.com/products/551C

The SEL-551 provides complete overcurrent protection and multishot reclosing in one compact relay. It replaces many relays and control switches and much of the wiring required in traditional distribution substation protection and control panels. The relay also replaces line recloser control packages at a fraction of the cost. The SEL-551C provides flexibility in distribution system protection by offering six inputs, three outputs, and two communications ports for more control options. SELOGIC® control equations offer rising- and falling-edge triggers and latches for custom logic applications.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
50	Adaptive Overcurrent
51N	Neutral Time Overcurrent
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
79	Autoreclosing

ADDITIONAL FUNCTIONS	
DFR	Event Reports
HMI	Operator Interface
LGC	SELOGIC Control Equations
MET	High-Accuracy Metering
SER	Sequential Events Recorder

*Optional feature

DISTRIBUTION CONTROL OVERVIEW

SEL-FT50 AND SEL-FR12

The SEL-FT50 and SEL-FR12 System speeds up distribution protection with fault indication in 6 ms.

SEL-651R

The SEL-651R provides automatic network reconfiguration, three-phase and single-phase tripping, and other distribution automation solutions. It is compatible with popular reclosers.

SEL-651RA

The SEL-651RA is a powerful, cost-effective, and flexible recloser control for 14-pin applications. It is compatible with popular reclosers.

SEL-351RS KESTREL®

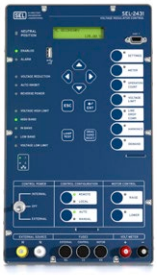
The SEL-351RS provides integrated logic and communications and comprehensive protection for single-phase applications.

SEL-734B

The SEL-734B includes low-energy analog inputs and provides advanced monitoring and control capabilities for applications such as capacitor bank control and feeder monitoring.

SEL-734W

The enhanced SEL-734W and SEL-8340 Wireless Current Sensor solution provides advanced capacitor bank control to improve power quality.



SEL-2431

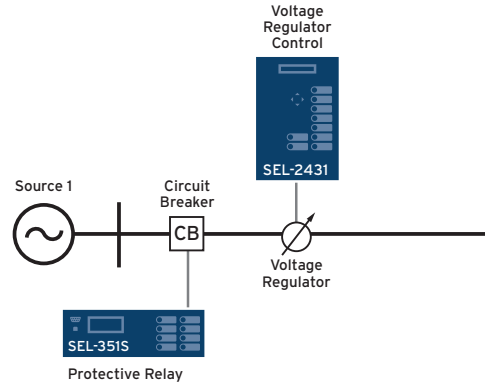
The SEL-2431 optimizes system voltages by using directional voltage profiles and detailed tap change event reports.

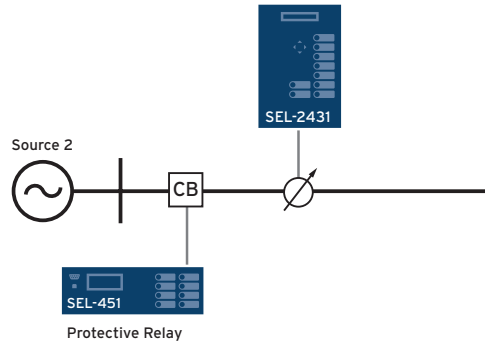
	SEL-351RS	SEL-651RA	SEL-651R
APPLICATIONS			
Distribution Feeder Protection	•	•	•
Breaker Failure Protection	f	f	f
Generator Intertie Protection		•	•
Synchronism Check		+	•
Underfrequency Load Shedding	•	•	•
Undervoltage Load Shedding	•	•	•
PROTECTION			
25 (G,T) Generator/Intertie Synchronism Check		•	•
27/59 Under-/Overvoltage	•	•	•
32 Directional Power Elements	•	+	•
50 (P,N,G,Q) Overcurrent Element (Phase, Neutral, Ground, Negative Sequence)	•	•	•
51 (P,N,G,Q) Time-Overcurrent Element (Phase, Neutral, Ground, Negative Sequence)	•	•	•
67 (P,N,Q) Directional Overcurrent (Phase, Neutral, Negative Sequence)		•	•
78VS Vector Shift		•	•
81 Over-/Underfrequency	•	•	•
Separate Neutral Overcurrent		•	•
Load Encroachment Supervision		•	•
Low-Energy Analog (LEA) Voltage Inputs		+	+
Directional Sensitive Earth Fault Protection		•	•
Pilot Protection Logic		f	f
Rate-of-Change of Frequency (df/dt)	•	•	•
Fast Rate-of-Change of Frequency		•	•
Harmonic Blocking	•	•	•
Arc Sense™ Technology (AST) High-Impedance Fault Detection		+	+
Phantom Phase Voltage	•	•	•
Current/Voltage Channels	1/1	4/1 4/6+	4/6
INSTRUMENTATION AND CONTROL			
79 Automatic Reclosing	•	•	•
Fault Locating	•	+	•
SELOGIC® Control Equations With Remote Control Switches	•	•	•
SELOGIC Counters	•	•	•
Voltage Check on Closing	•	•	•
SELOGIC Nonvolatile Latch	•	•	•
Nonvolatile Local Control Switches	•	•	•
Breaker/Recloser Wear Monitor	•	•	•
Trip Coil Monitor	f	f	f
Voltage Sag, Swell, and Interruption (VSSI)	•	+	•
Load/Signal Profile Recorder	•	•	•
Sequential Events Recorder	•	•	•
DNP3 Level 2 Outstation	•	•	•
IEEE C37.118 Synchrophasors	•	•	•
Ethernet	•	•	•
IEC 61850	+	+	+
Simple Network Time Protocol (SNTP)	•	•	•
Harmonic Metering	•	•	•
RMS Metering	•	•	•

• Standard feature + Model option f May be created using settings

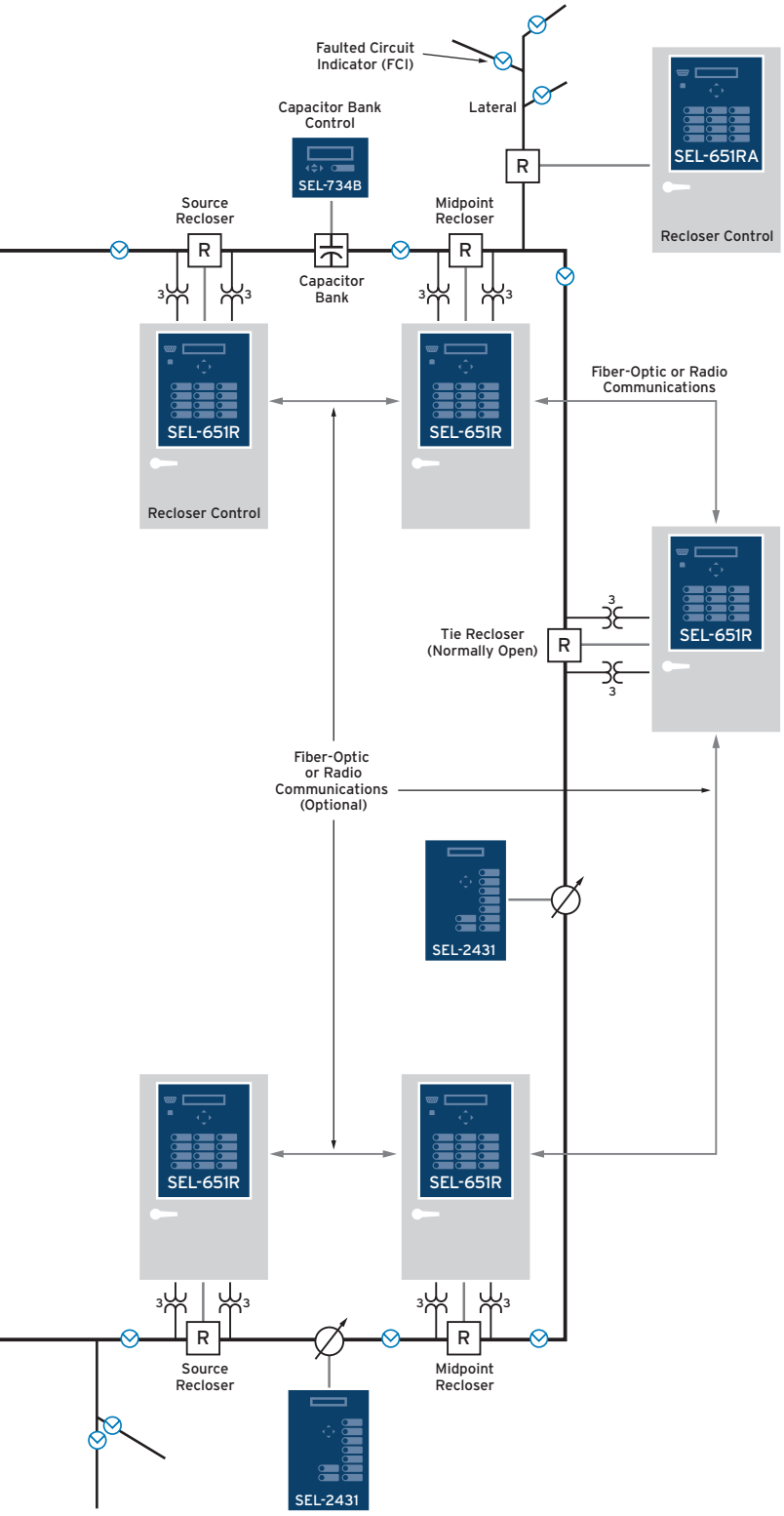
RECLOSER COMPATIBILITY

	SEL-351RS	SEL-651RA	SEL-651R
G&W			
Control Power Viper-S			•
Viper-G		•	•
Viper-LT			•
Viper-S		•	•
Viper-SP	•		•
Viper-ST			•
OTHER RECLOSERS			
Elastimold Molded Vacuum Recloser (MVR)	•		•
Joslyn TriMod 300R		•	•
Joslyn TriMod 600R			•
OVR 24-Pin (15 and 27 kV)			•
OVR 32-Pin (15, 27, and 38 kV)			•
OVR 42-Pin (15, 27, and 38 kV)			•
VR-3S (15 and 27 kV)			•
CXE		•	•
NOVA Auxiliary-Powered		•	•
NOVA Control-Powered			•
NOVA NX-T			•
NOVA Triple-Single			•
RE		•	•
RVE		•	•
RXE		•	•
VSA		•	•
VSO		•	•
VWE		•	•
VWVE 27		•	•
VWVE 38X		•	•
WE		•	•
WVE 27		•	•
WVE 38X		•	•
GVR (when equipped with interface module)		•	•
SDR Triple-Single		•	•
SDR Three-Phase		•	•
OSM_150_AI_4			•





DISTRIBUTION CONTROL APPLICATIONS



DNA® (DISTRIBUTION NETWORK AUTOMATION)

Use SEL DNA solutions to automate complex distribution networks by combining SEL distribution relays, recloser controls, voltage regulators, capacitor bank controllers, and automation controllers. You can reconfigure and optimize networks based on a complex combination of load, capacity, and other criteria.

Automatic Network Reconfiguration

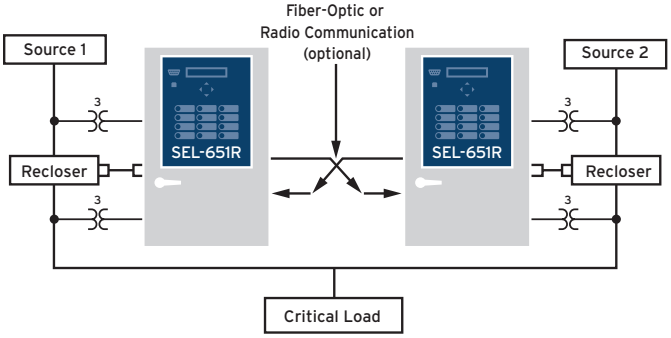
Improve service reliability with Automatic Network Reconfiguration (ANR) by isolating permanently faulted segments and quickly restoring service to nonfaulted segments. ANR is possible in a variety of systems, either with or without communications. With single-phase tripping, you can isolate only the faulted phase for additional service reliability.

Capacitor Bank Control

Combine volt/VAR-based capacitor bank control with power quality monitoring and advanced reporting to improve power factor and system efficiency. The SEL-734B Advanced Monitoring and Control System adapts to multiple capacitor bank control applications, ranging from basic three-phase control to intelligent single-phase control.

Voltage Regulation

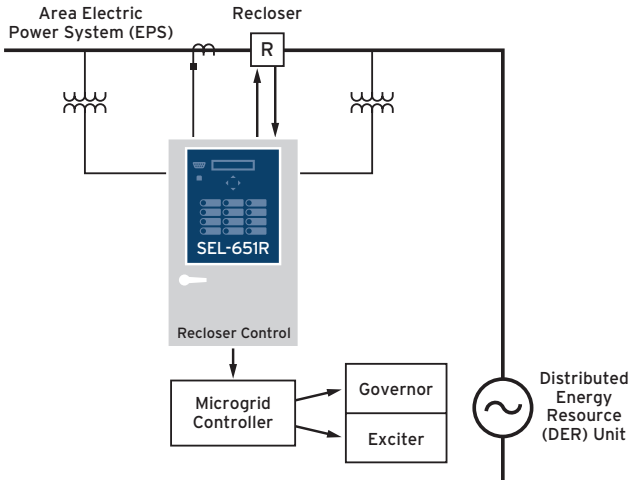
Control your single-phase voltage regulators to level the voltage profile and optimize your system. Voltage regulation is adaptable to fit your application. For example, you can select the locked-forward mode with traditional radial feeders. For looped systems, a bidirectional mode offers different settings based on the direction of current flow.



Autosource Transfer Schemes

Maintain reliable power with the SEL-651R Advanced Recloser Control for critical loads that require dual-feeder service. You can make intelligent operation decisions to bring nonfaulted loads back online using SEL MIRRORED BITS® communications technology between recloser controls. MIRRORED BITS lets you communicate securely and share recloser status, source status, and other logic information between SEL-651R Recloser Controls.

Customize the return-to-normal action by incorporating a synchronism check for parallel source return or break-before-make when source voltages are not in phase.



Distributed Energy Resource Interconnection

Meet synchronization and tripping requirements when connecting microgrids and distributed generation to distribution systems. Voltage, frequency, synchronism-check, and automatic synchronizing elements provide seamless connections. You can easily disconnect generation from the distribution system for faults, islanding, and other abnormal conditions.

SEL-FT50 AND SEL-FR12

FAULT TRANSMITTER AND RECEIVER SYSTEM

Starting Price

SEL-FT50 Fault Transmitter: $180 USD

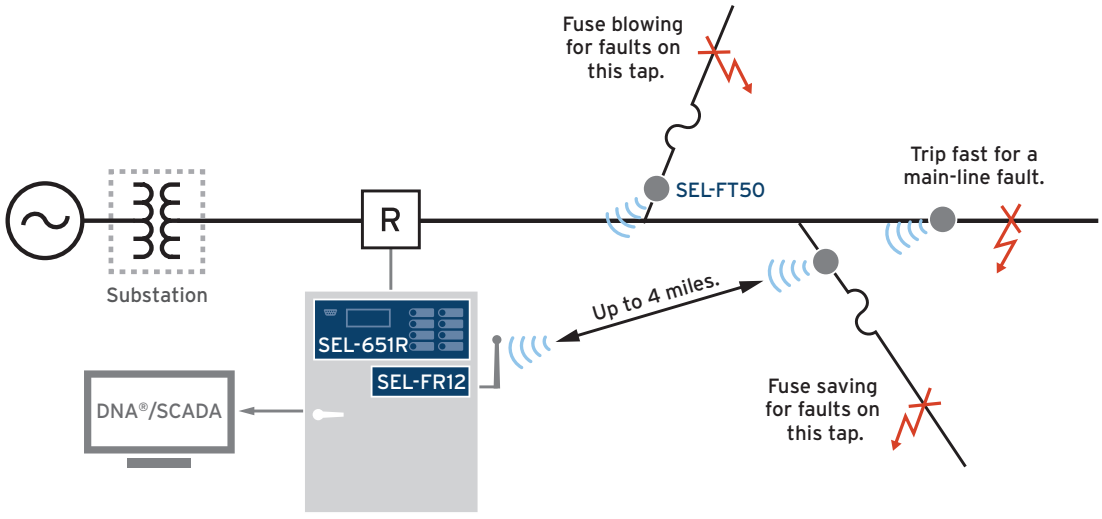
SEL-FR12 Fault Receiver: $549 USD

selinc.com/products/FT50

Select models typically ship in 2 days

The SEL-FT50 and SEL-FR12 System provides an innovative approach for speeding up distribution protection schemes without sacrificing selectivity. You can apply this system with your existing protection schemes to eliminate the need for coordination delays between fuses and protective relays. The system consists of line-powered SEL-FT50 Fault Transmitters communicating wirelessly with an SEL-FR12 Fault Receiver over distances up to 4 miles. The system communicates the fault data using high-speed MIRRORED BITS® communications to any SEL device—in less than 6 ms.

Fast detection and communications enable coordination tailored to specific events. This allows your protection to trip for faults as fast as possible and allows you to selectively decide when reclosing should be enabled, improving safety and reducing wear on equipment. You can install the SEL-FT50 Fault Transmitters on laterals, branches, and the main line to provide additional information for protection decisions. When combined with the SEL-651R Advanced Recloser Control or other SEL distribution protection relays, the SEL-FT50 and SEL-FR12 System provides additional information to the relays to enable enhanced protection.



6 ms from fault detection to the recloser control allows you to enhance protection based on the fault location.

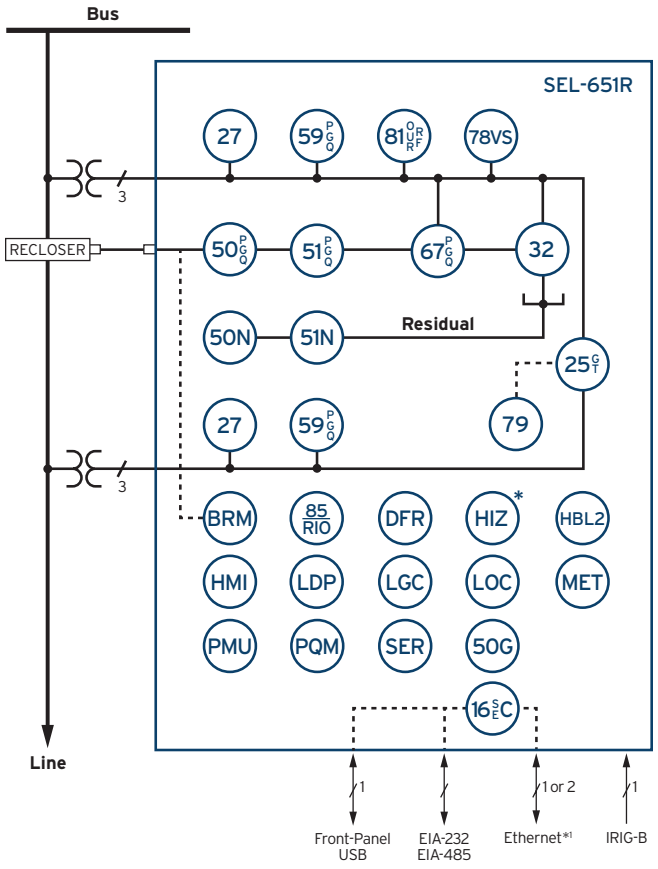
SEL-651R

ADVANCED RECLOSER CONTROL

Starting Price
$5,850 USD

selinc.com/products/651R

The SEL-651R offers exceptional protection and communications capabilities for automatic network reconfiguration, single- and three-phase tripping, distributed energy resource (DER) interconnections, turnkey point of common coupling solutions, and other distribution automation needs. These capabilities help you maintain reliable service to as many customers as possible in the event of a fault. You can quickly commission the SEL-651R by applying just the settings you need using ACSELERATOR QuickSet® SEL-5030 Software. Easy-to-use design templates simplify the settings interface, and you can customize them for your needs. For quick access when making settings changes, you can store templates on the recloser control.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
25 (G,T)	Generator/Intertie Synchronism Check
27	Undervoltage
32	Directional Power
50G	Best Choice Ground
50N	Neutral Overcurrent
50 (P,G,Q)	Overcurrent (Phase, Ground, Negative Sequence)
51 (P,G,Q)	Time Overcurrent (Phase, Ground, Negative Sequence)
51N	Neutral Time Overcurrent
59 (P,G,Q)	Overvoltage (Phase, Ground, Negative Sequence)
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Negative Sequence)
78VS	Vector Shift
79	Autoreclosing
81 (O,U,R)	Frequency (Over, Under, Rate)
81RF	Fast Rate-of-Change of Frequency
85 RIO	SEL MIRRORED BITS® Communications
DFR	Event Reports
HIZ	SEL Arc Sense™ Technology (AST)*
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
PQM	Voltage Sag, Swell, and Interruption
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
HBL2	Second-Harmonic Blocking
LDP	Load Data Profiling
LOC	Fault Locator

*Optional feature [1]Copper or fiber-optic

64 SELOGIC variables replace traditional panel switches with 32 latching, 16 local, and 32 remote control points.

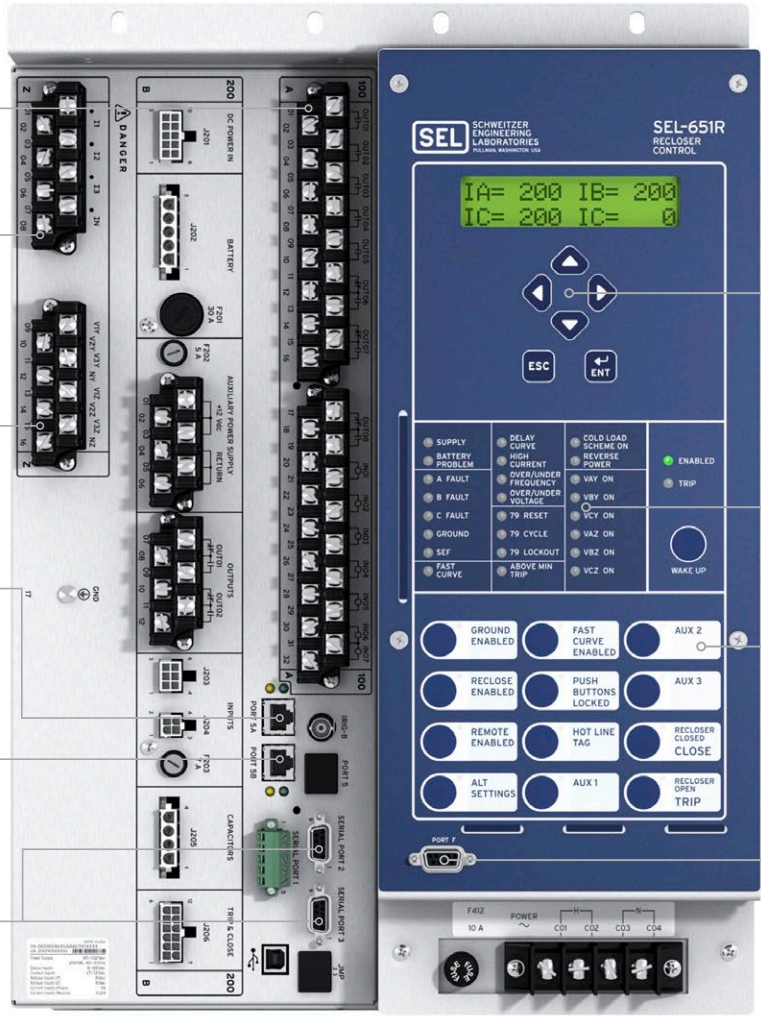
Built-in synchrophasor measurements for real-time electrical quantities.

Standard six voltage inputs with PT and low-energy analog (LEA) options for measurements on both sides of the recloser.

Standard multisession Modbus TCP and DNP3 and optional IEC 61850 easily integrate with existing systems.

Standard dual copper Ethernet ports and optional single or dual fiber ports for improved communications.

Two standard EIA-232 ports, an EIA-485 port, and a USB port provide several communications options.



Navigation controls make information readily accessible.

Optional software-programmable tricolored LEDs for improved status indication.

Programmable control pushbuttons and configurable labels for ease of operation.

EIA-232 front serial port provides local access.

Single-door control option shown.

COMPATIBLE WITH POPULAR RECLOSERS

The SEL-651R works with a wide range of reclosers for complete plug-and-work capability. All interfaces are designed and tested to exceed the IEEE C37.60 standard. Certificates are available at **selinc.com/products/SEL-651R**.

G&W
Control Power Viper-S
Viper-LT
Viper-S
Viper-SP
Viper-ST
Viper-G

OTHER RECLOSERS	
Elastimold Molded Vacuum Recloser (MVR)	RXE
Joslyn TriMod 300R	VSA
Joslyn TriMod 600R	VSO
OVR 24-Pin (15 and 27 kV only)	VWE
OVR 32-Pin (15, 27, and 38 kV)	VWVE 27
OVR 42-Pin (15, 27, and 38 kV)	VWVE 38X
VR-3S (15 and 27 kV only)	WE
CXE	WVE 27
NOVA Auxiliary Powered	WVE 38X
NOVA Control Powered	GVR*
NOVA NX-T	SDR Triple-Single
NOVA Triple-Single	SDR Three-Phase
RE	OSM_150
RVE	

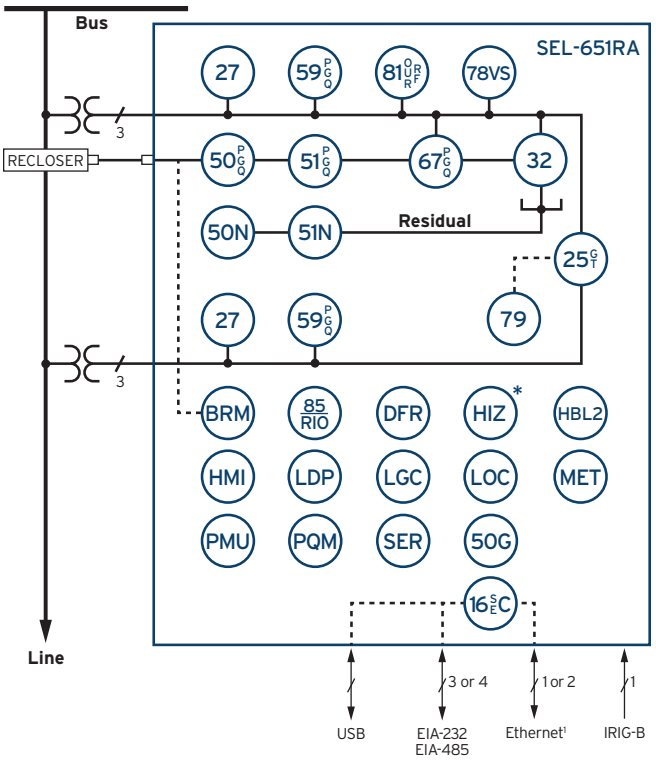
*When equipped with interface module

SEL-651RA
RECLOSER CONTROL

Starting Price
$3,900 USD

selinc.com/products/651RA

The SEL-651RA offers exceptional protection and communications capabilities for automatic network reconfiguration, distributed energy resource (DER) control, turnkey point of common coupling solutions, and other distribution automation needs. These capabilities help you maintain reliable service to as many customers as possible in the event of a fault. You can quickly commission the SEL-651RA by applying just the settings you need using ACSELERATOR QuickSet® SEL-5030 Software. Easy-to-use design templates simplify the settings interface, and you can customize them for your needs. For quick access when making settings changes, you can store the templates on the recloser control. Familiar EZ recloser control settings further simplify and speed commissioning for basic applications.



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78VS	Vector Shift
79	Autoreclosing
81 (O,U,R)	Frequency (Over, Under, Rate)
81RF	Fast Rate-of-Change of Frequency
85 RIO	SEL MIRRORED BITS® Communications
DFR	Event Reports
HIZ	SEL Arc Sense™ Technology (AST)*
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
PQM	Voltage Sag, Swell, and Interruption
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
HBL2	Second-Harmonic Blocking
LDP	Load Data Profiling
LOC	Fault Locator

*Optional feature

[1]Copper or fiber-optic

COMPATIBLE WITH POPULAR RECLOSERS

The SEL-651RA works with traditional 14-pin reclosers and can be configured for complete plug-and-work capability. The interface is designed and tested to exceed the IEC 62271-111/IEEE C37.60 standard. Certificates for the Eaton (Cooper) NOVA and G&W Viper-S reclosers are available at **selinc.com/products/SEL-651RA**.

G&W
Viper-S
Viper-G

OTHER RECLOSERS	
Joslyn TriMod 300R	VWE
NOVA Auxiliary Powered	VWVE 27
CXE	VWVE 38X
RE	WE
RVE	WVE 27
RXE	WVE 38X
VSA	GVR*
VSO	*When equipped with interface module.

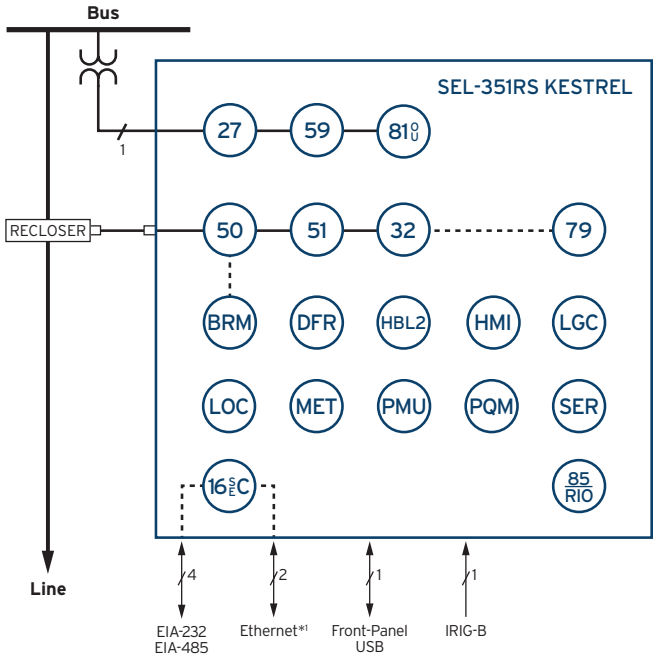
SEL-351RS KESTREL®

SINGLE-PHASE RECLOSER CONTROL

Starting Price
$2,500 USD

selinc.com/products/351RS_Kestrel

The lightweight SEL-351RS provides integrated logic, communications, and comprehensive protection for single-phase applications. Convenient operator controls allow easy local access to metering and event data. The rugged, painted aluminum enclosure reduces the need for cabinet maintenance and repairs. With built-in USB, serial, and Ethernet media and protocols, including IEC 61850 and IEEE C37.118 synchrophasors, you can easily integrate this control into new or existing systems. Familiar EZ recloser control settings further simplify and speed commissioning for basic applications.



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
16 SEC	Access Security (Serial, Ethernet)
27	Undervoltage
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59	Overvoltage
79	Autoreclosing
81 (O,U)	Over-/Underfrequency
85 RIO	SEL Mirrored Bits® Communications
DFR	Event Reports
HMI	Operator Interface
LGC	SELogic® Control Equations
MET	High-Accuracy Metering
PMU	Synchrophasors
PQM	Voltage Sag, Swell, and Interruption
SER	Sequential Events Recorder

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
HBL2	Harmonic Blocking
LDP	Load Data Profiling
LOC	Fault Locator

*Optional feature [1]Copper or fiber-optic

COMPATIBLE WITH POPULAR RECLOSERS

The SEL-351RS works with the G&W Viper-SP single-phase recloser and the ABB Elastimold Molded Vacuum Recloser (MVR), and it can be configured for complete plug-and-work capability. The interface is designed and tested to exceed the IEC 62271-111/IEEE C37.60 standard. Certificates for popular single-phase reclosers are available at **selinc.com/products/351RS_Kestrel**.

SEL-734B

ADVANCED MONITORING AND CONTROL SYSTEM

Starting Price
$1,600 USD

selinc.com/products/734B

In addition to the compact enclosure, the SEL-734B is available as a standalone unit or in a full-size enclosure.

The SEL-734B with low-energy analog (LEA) inputs provides advanced monitoring and control capabilities for applications such as capacitor bank control and feeder monitoring. LEA sensor compatibility allows safe, fast, and inexpensive installations. Advanced communications let you report data to SCADA systems and allow remote operations from a control center. You can order enclosures with preloaded control schemes or design custom controls, such as capacitor bank controllers or sectionalizers, using ACSELERATOR QuickSet® SEL-5030 Software templates. SEL's capacitor bank control and sectionalizer templates improve efficiency, increase reliability, and reduce installation time and maintenance costs. User-customized templates add flexibility, improving any smart grid installation.

SEL-734W

CAPACITOR BANK CONTROL

Contact SEL for More Information

selinc.com/products/734W

An SEL-734W Capacitor Bank Control is paired with one to three SEL-8340 Wireless Current Sensors.

The enhanced SEL-734W and SEL-8340 Wireless Current Sensor solution provides advanced capacitor bank control to improve power quality. SEL-8340 sensors communicate current values via unlicensed 900 MHz wireless signals to the SEL-734W. The SEL-734W uses current, voltage, kVARs, and power factor control to optimize capacitor bank switching. The SEL-734W and SEL-8340 solution makes replacing time- and temperature-based capacitor bank controls faster and easier by eliminating the need to install traditional current sensors and cabling.

SEL-2431

VOLTAGE REGULATOR CONTROL

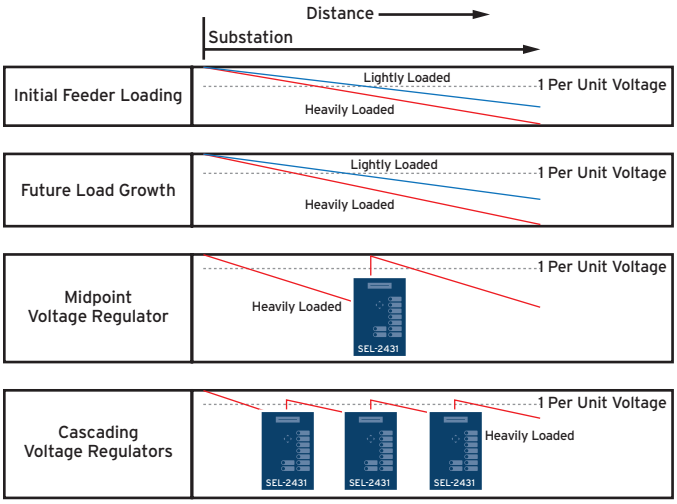
Starting Price
$930 USD

selinc.com/products/2431
Select models typically ship in 2 days

The SEL-2431 is compatible with most 32-step, single-phase voltage regulators manufactured in North America. Various hinge and wiring kits let you easily upgrade existing controls without removing the regulator from service. You can quickly integrate the SEL-2431 into Ethernet or serial communications networks using fiber or copper options.

CREATING THE OPTIMUM PROFILE

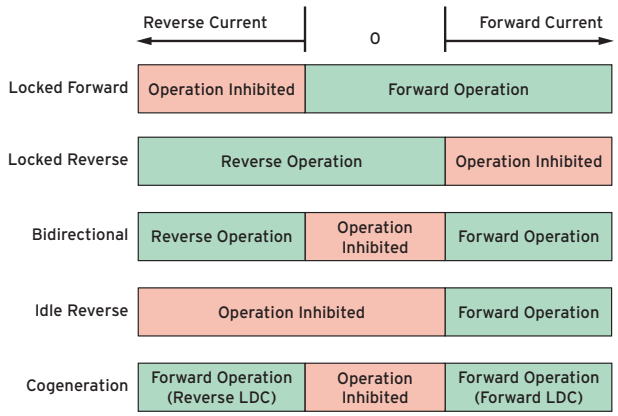
Apply the SEL-2431 to your single-phase voltage regulators to optimize your voltage profile. After initial construction, feeder load growth causes drastic, unplanned voltage deviations. Single-phase voltage regulators installed at the midpoint or cascaded throughout the feeder can dramatically flatten the voltage profile.

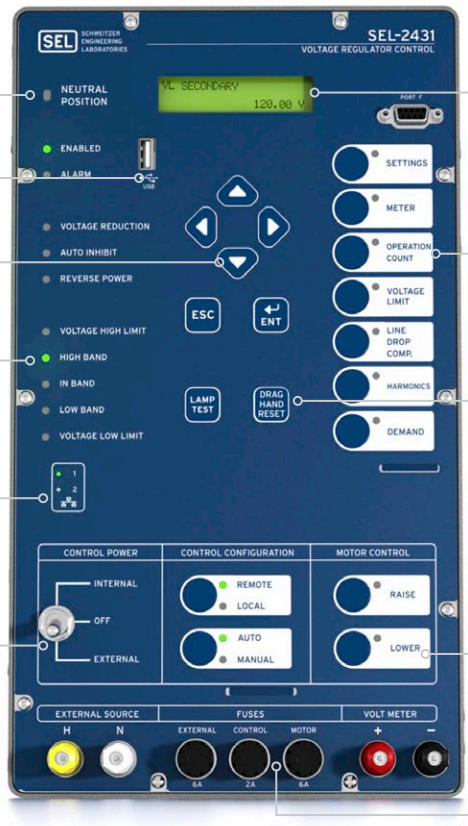


MODES OF OPERATION

Program the SEL-2431 quickly and easily for your application. With configurable modes of operation, you can apply the SEL-2431 in locked-forward, locked-reverse, bidirectional, idle-reverse, or cogeneration modes.

For example, you can select the locked-forward mode for systems configured with traditional radial feeders. For looped systems where current can flow in either direction, the bidirectional mode will dynamically change the voltage regulation settings based on the direction of current flow.





Neutral position indicator

USB flash drive port

Simple menu navigation

System status indicators

Ethernet link indication

Internal/external power switch

Configurable display points

Seven configurable pushbuttons and LEDs

Drag hand reset

Raise/lower pushbuttons or toggle switch

Separate fuses to protect the controller and the motor operator

Optional "snap-in" communications cards

Serial communications port

Chassis ground

Connectorized® I/O

Dual Ethernet communications ports

Voltage input

Current input

Voltage regulator interface

FAULT INDICATORS, SENSORS, AND CTs OVERVIEW

SEL-FLT AND SEL-FLR NEW

Improve distribution reliability with the SEL-FLT and SEL-FLR System, which enables faster fault locating, reduces outage durations, and improves the average restoration time.

SEL-AR360 AND SEL-AR

Locate momentary and permanent faults in overhead applications. The SEL-AR360 and SEL-AR automatically adjust their trip thresholds to coordinate with the load current in distribution systems up to 69 kV.

SEL-ER

Provide maintenance-free fault indication with a battery-free design and automatic voltage reset.

SEL-BTRIP

Locate momentary and permanent faults in overhead applications. The SEL-BTRIP provides four field-selectable trip thresholds so you can stock one fault indicator for multiple applications.

RADIORANGER®

Reduce the need to access vaults or open pad-mounted enclosures to retrieve the fault indicator status, decreasing fault-locating time and improving safety.

SEL-8301

Optimize outage management and improve underground system reliability.

SEL-ARU

Use the Dynamic Delayed Trip feature to improve coordination with upstream protection, maximizing reliable performance.

SEL-PILC

Apply the SEL-PILC on paper-insulated lead-covered cables. It features a rugged design and can be submerged in up to 15 feet of water.

SEL-8315

Locate faults in underground transmission cables, and wirelessly communicate the fault status to line crews using the RadioRANGER.

SEL-TPR

Easily install the SEL-TPR on most brands of 200 A or 600 A elbows with capacitive test points. It is ideal for pad-mounted transformer and switchgear applications.

SEL-CR

Monitor underground systems with the SEL-CR, which is powered by the load current present on an energized line.

SEL-SR

Apply the SEL-SR to pad-mounted transformers when there is insufficient primary current to power and reset current-powered fault indicators.

SEL-GFD

Apply the SEL-GFD over a three-phase cable bundle at ground potential in switchgear to identify faults on circuits feeding medical facilities, mining equipment, and other industrial equipment.

SEL-MW

Use the SEL-MW in place of PTs to detect system voltage loss where exact system voltage measurement reporting is not required. The SEL-MW indicates voltage loss via a contact output.

SEL-TR

Indicate both momentary and permanent faults in underground distribution systems with low load and low voltage.

SEL-MR

Troubleshoot overhead and underground applications up to 38 kV with this portable, fault-powered manual reset fault indicator.

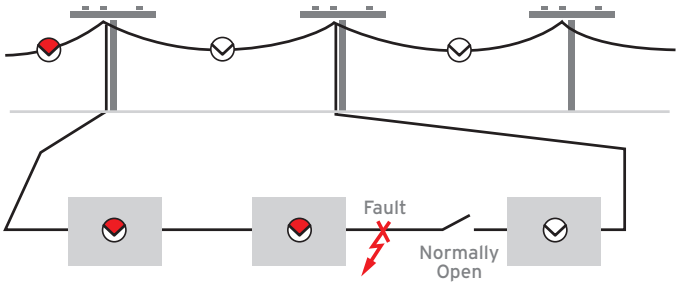
SEL-VIN

Easily install SEL-VINs on the test point of a 200 A elbow, 600 A T-body, or 600 A basic insulating plug. The line-powered SEL-VIN indicates the presence of voltage at or above 2 kV (phase to ground) by flashing a neon lamp.

SEL-CT AND SEL-SCT

Economically add SEL CTs to existing wiring and electrical equipment without interrupting service.

FAULT INDICATORS AND SENSORS APPLICATIONS



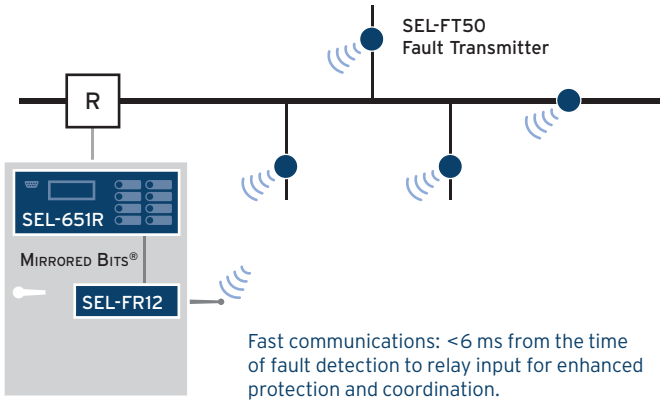
Reduce fault-locating time by 50 percent or more.

OVERHEAD, UNDERGROUND, AND WIRELESS APPLICATIONS

Easy-to-see displays on SEL fault indicators lead the line crew to the faulted section of the overhead line or underground cable, allowing personnel to visually identify the faulted line section without going through a time-consuming re-fuse and sectionalize process. Applying fault indicators in areas affected by permanent and momentary outages helps resolve disruptions quickly.

Wireless technology further speeds up fault-finding times by reducing the need for patrolling the line to locate the fault. Use SEL fault indicators with distribution protection and automation equipment to improve system reliability indices and reduce operational and maintenance costs.

Improve system planning and operational decision-making by using accurate load data from either the SEL-8301 Underground Distribution Sensor or the SEL-FLT and SEL-FLR Fault and Load Transmitter and Receiver System. These solutions provide underground or overhead load monitoring capability in addition to fault indication.



Fast communications: <6 ms from the time of fault detection to relay input for enhanced protection and coordination.

HIGH-SPEED DISTRIBUTION PROTECTION

Improve speed, selectivity, and safety in distribution protection by using the SEL-FT50 and SEL-FR12 Fault Transmitter and Receiver System. Using low-latency communications, the system is fast enough to adapt protection schemes to speed up tripping, block reclosing for underground faults, and improve coordination.

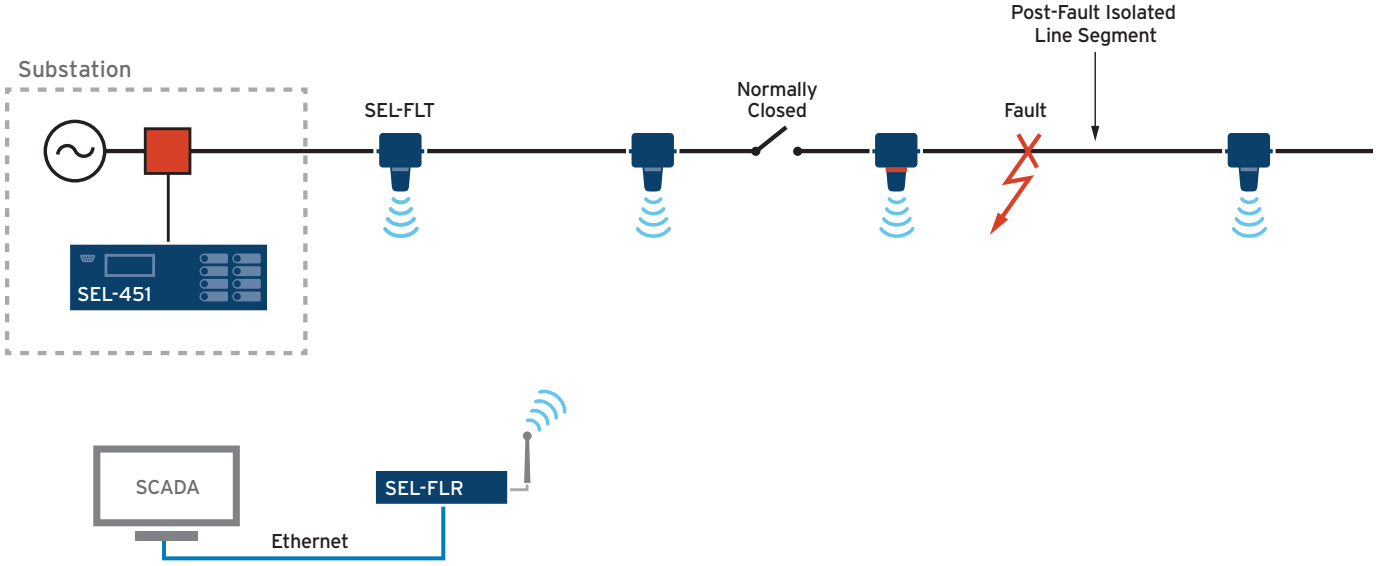
To learn more about the SEL-FT50 and SEL-FR12 System, visit **selinc.com/products/FT50**.

SEL-FLT and SEL-FLR Fault and Load Transmitter and Receiver System.

INTEGRATION WITH DISTRIBUTION SYSTEMS

The SEL-FLT and SEL-FLR System interconnects with existing SCADA, outage management, and distribution management systems to improve situational awareness.

Place SEL-FLT Transmitters next to manual- or remote-operated switches to quickly communicate fault and load status to a single SEL-FLR connected to a distribution management system through an IP backhaul. This provides operations personnel with the status confirmation needed to reconfigure the circuit and restore power to as many customers as possible.



Communicate the fault location to a SCADA system for quick power restoration.

SEL-FLT AND SEL-FLR NEW

FAULT AND LOAD TRANSMITTER AND RECEIVER SYSTEM

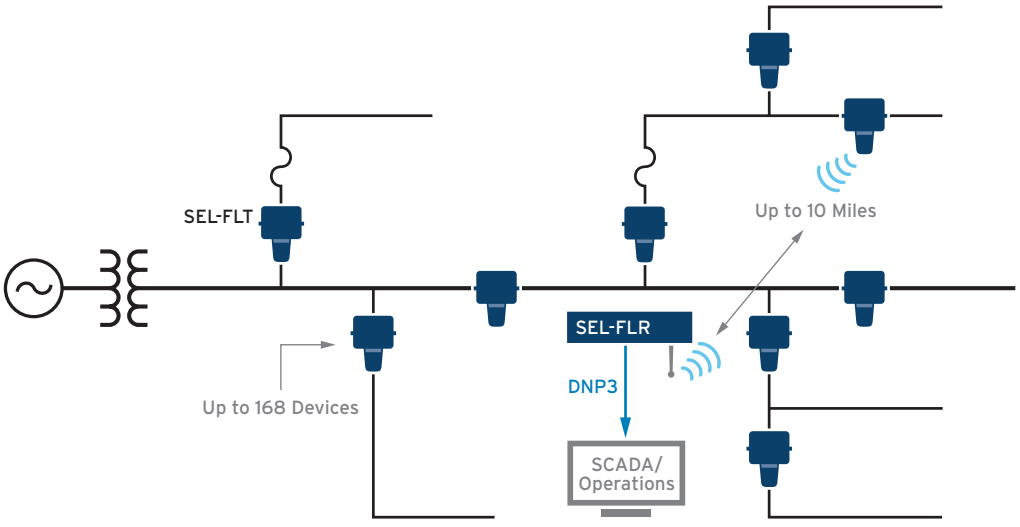
Starting Price

SEL-FLT Fault and Load Transmitter: $850 USD

SEL-FLR Fault and Load Receiver: $1,200 USD

selinc.com/products/FLT

The SEL-FLT and SEL-FLR System improves the overall reliability of your distribution system through accurate fault indication and load monitoring. The SEL-FLT Fault and Load Transmitter and the SEL-FLR Fault and Load Receiver work together over unlicensed 900 MHz wireless communications with a range of up to 10 miles (line of sight) to locate faults faster and make informed switching decisions. Restoring power quickly is essential to ensuring satisfied customers and better Customer Average Interruption Duration Index (CAIDI) reliability metrics. Locating momentary faults also allows you to address system issues and improve Momentary Average Interruption Frequency Index (MAIFI) metrics. Highly accurate (1% typical) load data enable phase balancing and system planning. Line powering, with as little as 3.5 A of continuous current, reduces ongoing maintenance and allows you to use the SEL-FLT throughout your distribution system. SEL-FLR Receivers are easy to integrate in existing systems with DNP3/IP output and comprehensive security.



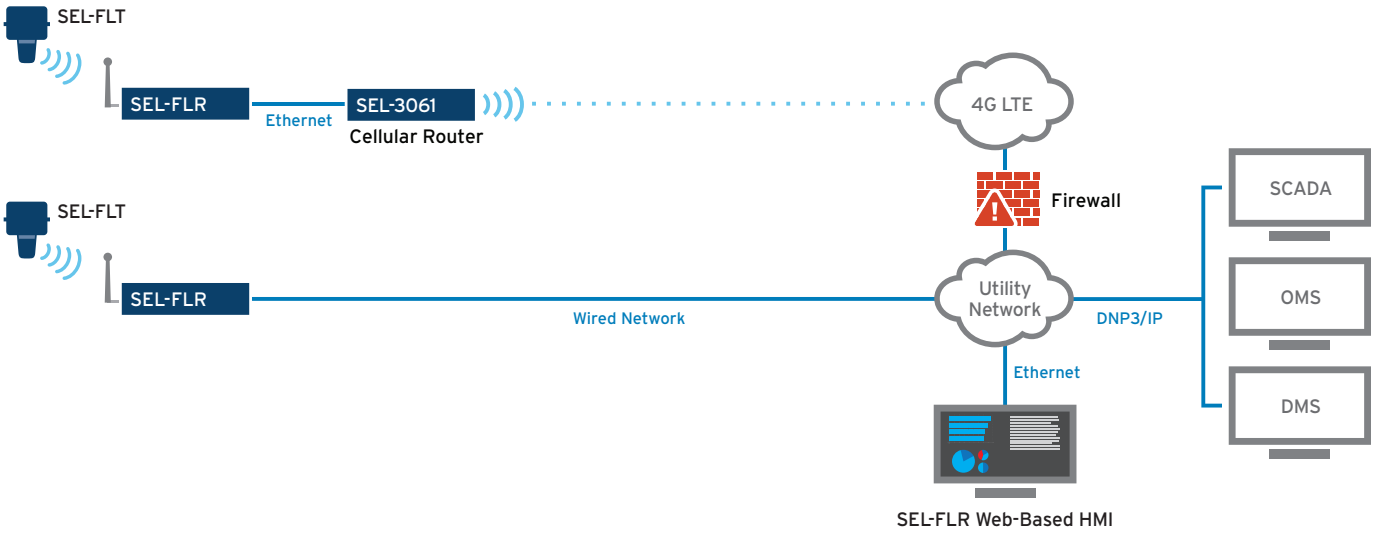
SEL-FLT AND SEL-FLR SYSTEM INTEGRATES WITH YOUR EXISTING SYSTEM

The SEL-FLR integrates easily into existing networks and centralized SCADA systems with standard Ethernet ports and DNP3/IP output. The SEL-FLR can pair with a cellular modem/router or Ethernet radio or plug directly into a wired Ethernet network. Once connected, data from the SEL-FLT Transmitters can flow into a SCADA system, outage management system (OMS), or distribution management system (DMS). You can perform configuration and troubleshooting of the SEL-FLT and SEL-FLR System over the network.

With fault information from the SEL-FLT and SEL-FLR System, utility operations teams can dispatch crews to fault locations faster, speeding up restoration. Flashing LEDs on the SEL-FLT Transmitters help line crews confirm the fault location reported through a SCADA system or OMS.

The SEL-FLT and SEL-FLR System can also help locate momentary faults. Addressing the causes of these faults, such as overgrown tree limbs or aging insulators, reduces future faults and momentary interruptions.

Highly accurate and frequent load data from SEL-FLT Transmitters on taps and laterals enables better decision-making in emergency switching situations. Load data are also essential for phase balancing, system planning, and identifying power theft.



SEL-AR360 AND SEL-AR

OVERHEAD AUTORANGER® FAULT INDICATORS

Starting Price

SEL-AR360: $212 USD

SEL-AR: $159 USD

selinc.com/products/AR

The SEL-AR360 and SEL-AR are self-adjusting fault indicators for distribution systems. The advanced algorithms in the microprocessor-based technology continually measure the load current and automatically step up or down the trip threshold to coordinate with the load. After an event, the fault indicators analyze system conditions to determine a display notification of either a momentary or permanent fault. They also use inrush restraint technology that activates on the loss of current or voltage to prevent tripping on reclosing attempts.

SEL-AR360

The SEL-AR360 works on systems up to 34.5 kV and offers 1,800 flashing hours and a 360-degree ultrabright flashing LED display.

Momentary fault indication.

Permanent fault indication.

SEL-AR

The SEL-AR works on systems up to 69 kV and offers 2,500 flashing hours and a forward-facing LED display.

Momentary fault indication.

Permanent fault indication.

SEL-ER

OVERHEAD ELECTROSTATIC RESET FAULT INDICATOR

Starting Price
$96 USD

selinc.com/products/ER

The line-powered SEL-ER displays a permanent fault condition by showing a large reflective red target. The red target remains visible until after the line is re-energized. The hermetically sealed UV-stabilized housing and stainless-steel clamp make the SEL-ER tough enough to handle harsh outdoor environments.

SEL-CRD

OVERHEAD CURRENT RESET FAULT INDICATOR

Starting Price
$152 USD

selinc.com/products/CRD

Powered by load current, the SEL-CRD reduces fault-finding time on overhead power distribution systems. It indicates a faulted line condition by showing a large red reflective target display. The SEL-CRD automatically resets upon restoration of load current.

SEL-BTRIP

OVERHEAD BEACON FIELD-PROGRAMMABLE TIMED-RESET FAULT INDICATOR

Starting Price
$184 USD

selinc.com/products/BTRIP

The SEL-BTRIP locates momentary or permanent faults in 4,160 V to 69 kV overhead system applications. It is quick and easy to apply using a single hot stick. The field-selectable trip threshold provides control of settings while allowing you to stock only one model. A super-bright flashing LED display provides clear indication of an overcurrent event. The SEL-BTRIP is completely powered by a 3.6 V high-capacity 8.5 Ah lithium battery with a 20-year shelf life.

SEL-BTRI

OVERHEAD BEACON TIMED-RESET FAULT INDICATOR

Starting Price
$120 USD

selinc.com/products/BTRI

The battery-powered overhead SEL-BTRI provides automatic reset at the end of a fixed reset period to allow time for crews to locate permanent and momentary faults. It is ideal for locations where false resets from backfeed are a concern, such as applications with single-phase sectionalizing on a three-phase circuit. The loss-of-voltage-activated inrush restraint feature prevents the SEL-BTRI from responding to automatic reclosing events.

RADIORANGER®

UNDERGROUND WIRELESS FAULT INDICATION SYSTEM

Starting Price

Interface, reader, and 3 FCIs: $943 USD

selinc.com/products/RadioRANGER

Look for this symbol to identify RadioRANGER-compatible fault indicators and sensors.

The RadioRANGER System reduces the need to access vaults to retrieve the status of faulted circuit indicators (FCIs), decreasing fault-locating times and improving utility personnel safety. Utility personnel can quickly and safely retrieve the subsurface FCI status at street level through communication between the SEL-8300 RadioRANGER Wireless Interface and the handheld SEL-8310 RadioRANGER Remote Fault Reader. A two-way communications link transmits both faulted (tripped) and normal (reset) status information, preventing any uncertainty in determining if FCIs are plugged into the interface and functioning.

The IP68-rated SEL-8300 and waterproof interconnection system (rated to 4.5 m [15 ft] of submersion in water) ensure environmental integrity for vault applications. Up to 12 SEL FCIs equipped with magnetic RadioRANGER Interface Probes inductively communicate their status to an SEL-8300. The rugged SEL-8310 provides the ID of nearby SEL-8300 Wireless Interfaces as well as the phase and direction of the fault path. To maximize application efficiency, the modular and scalable system works in a variety of vault configurations and offers an estimated 15 years of product life.

SEL-8300 RadioRANGER Wireless Interface

The Wireless Interface communicates fault indicator information to the Remote Fault Reader.

Integrated antenna (or optional remote antenna).

Eight easy-to-set IDs allow application in dense areas.

Connects up to 12 fault indicators wired with RadioRANGER Interface Probes.

Sealed, waterproof, and IP68-rated case.

Circuit and cable phase labels debossed next to ports to make it simple to match FCIs with cables and circuits during installation.

SEL-8310 RadioRANGER Remote Fault Reader

The Remote Fault Reader identifies the phase and location of underground faults.

Flexible antenna.

Durable, buoyant case rated to IP54.

Wireless Interface health monitor.

Displays up to eight unique Wireless Interface IDs.

Operates on three alkaline or rechargeable AA batteries.

Communicates fault indicator presence and status:
Red—Tripped fault indicator
Green—Untripped fault indicator
Off—No fault indicator present

Easy-to-use keypad.

SEL-8301

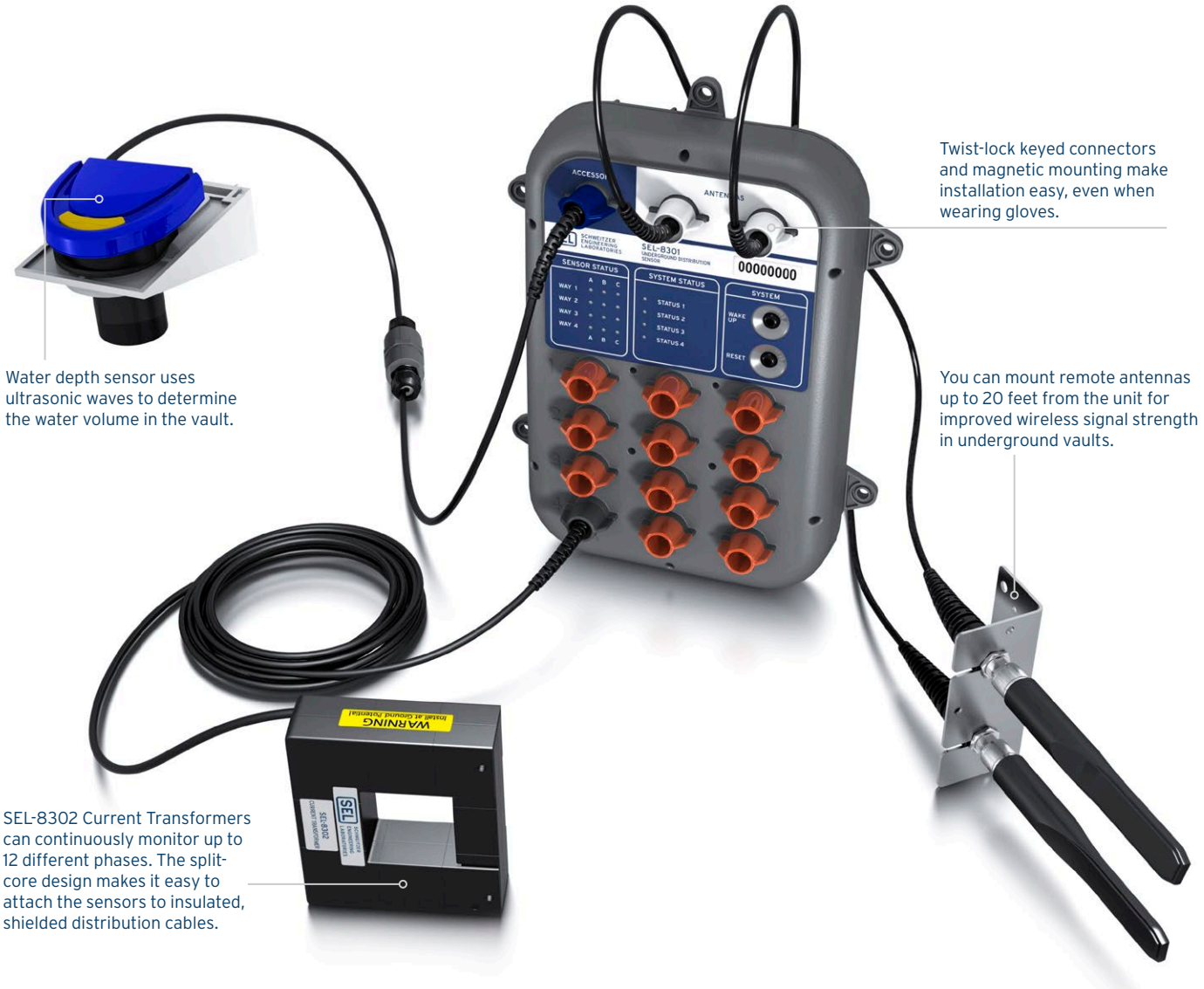
UNDERGROUND DISTRIBUTION SENSOR

Starting Price

Three-Phase System: $2,100 USD

selinc.com/products/8301

The SEL-8301 optimizes outage management and improves power system reliability. Using a wireless RPMA network, the SEL-8301 sends fault, load current, and water depth information to your control center so you can efficiently dispatch repair crews and reduce outage durations. With a line current measurement accuracy of 1.5 percent, it enables effective switching decisions, letting you restore power to more customers. The flexible design makes the SEL-8301 ideal for underground vaults, pad-mounted switchgear and transformers, and high-rise distribution feeders and transformer rooms.



SEL-ARU

UNDERGROUND AUTORANGER® FAULT INDICATOR

Starting Price
$109 USD

selinc.com/products/ARU

Compatible With RadioRANGER®

The SEL-ARU is a reliable, settings-free fault indicator that automatically selects a minimum trip threshold based on the sampled load current. This feature simplifies ordering and inventory, reduces maintenance, and simplifies applications. The Dynamic Delayed Trip feature automatically adjusts the trip response time to better coordinate with upstream protection, maximize performance, and increase the reliability of underground distribution systems.

Display options provide flexibility for pad-mounted or vault installations. The power options (line-powered or battery) and restoration reset features ensure reliable performance for any application.

SEL-ARU with integrated display.

SEL-ARU with fiber-optic display. Other display options are available.

SEL-PILC

UNDERGROUND PAPER-INSULATED LEAD-COVERED CABLE FAULT INDICATOR

Starting Price
$599 USD

selinc.com/products/PILC

Compatible With RadioRANGER

SEL-PILCs support a wide range of paper-insulated lead-covered cable (PILC) configurations and applications, including triplexed, single-phase, and three-phase sector (or round) cables from 5.58 to 11.78 cm (2.2 to 4.64 in.) in diameter. A split-core design lets you quickly and easily install the SEL-PILC without disconnecting the cable. Its rugged construction can withstand submersion in up to 4.5 m (15 ft) of water. The SEL-PILC is compatible with the RadioRANGER Underground Wireless Fault Indication System. Together, they make it easier and faster to find faults on urban systems.

SEL-8315

UNDERGROUND PHASE COMPARISON FAULT INDICATOR

Starting Price
$2,658 USD

selinc.com/products/8315

RadioRANGER® Required

The SEL-8315 is a fault indicator for underground transmission cable systems. It detects solid dielectric cable failures and quickly communicates faults to line crews using the RadioRANGER Underground Wireless Fault Indication System. There is no need to open, enter, pump, or drain multiple vaults or manholes to determine the fault status. The two primary applications for the SEL-8315 are monitoring underground splices and monitoring cable sections where a mix of overhead conductors and underground transmission cables results in inaccurate impedance-based distance-to-fault calculations. The SEL-8315 is submersible in up to 4.5 m (15 ft) of water and withstands harsh environments.

SEL-TPR

UNDERGROUND TEST POINT RESET FAULT INDICATOR

Starting Price
$69 USD

selinc.com/products/TPR

Compatible With RadioRANGER

The SEL-TPR is an underground fault indicator that attaches to capacitive test points in single- or three-phase systems. It replaces the protective cap on capacitive test points, with the benefit of providing fault indication. The SEL-TPR eliminates the need to account for the position of the concentric neutral, as is common with cable-mounted fault indicators. It automatically resets upon system voltage restoration. The SEL-TPR is easy to install with a hot stick attached to its molded rubber hook eye. Powered by line voltage, the SEL-TPR does not have a minimum current requirement, making it great for lightly loaded circuits.

You can choose from a variety of display options, including a built-in, battery-free mechanical flag display or a remote bright BEACON® LED display. Remote display options reduce fault-finding times by eliminating the need for crews to open medium-voltage enclosures during patrols.

SEL-CR

UNDERGROUND CURRENT RESET FAULT INDICATOR

Starting Price
$102 USD

selinc.com/products/CR

Compatible With RadioRANGER®

The SEL-CR uses continuous load current to automatically reset so it is ready to respond to faults. Powered by the load current on an energized underground distribution cable, the SEL-CR responds to a fault and remains in the faulted-display condition until the line is energized with normal line load.

SEL-SR

UNDERGROUND SECONDARY/LOW-VOLTAGE RESET FAULT INDICATOR

Starting Price
$85 USD

selinc.com/products/SR

Apply the SEL-SR in single- and three-phase pad-mounted transformer applications where there is insufficient load current or no capacitive test points to power fault indicators. The SEL-SR's reset cable feeds off the transformer secondary voltage to operate, eliminating the need for a battery.

SEL-GFD

UNDERGROUND GROUND FAULT DETECTOR

Starting Price
$204 USD

selinc.com/products/GFD

The SEL-GFD detects ground faults by sensing the vector sum of the current flowing through a three-conductor cable. You can install the split-core sensor on three-phase cables or a bundle of three single-phase cables without opening the primary. Three reset options are available: secondary voltage, load current, or time.

SEL-MW

MICROCONTROLLER-BASED WYE VOLTAGE SENSOR

Starting Price
$333 USD

selinc.com/products/MW

More economical than a PT or analog sensor, the SEL-MW detects system voltage loss where exact system voltage measurement reporting is not required. You can easily install the SEL-MW on capacitive test points of distribution elbows. It learns and adapts to the unique voltage output level of the capacitive test points to simplify product calibration.

SEL-TR

UNDERGROUND TIMED-RESET FAULT INDICATOR

Starting Price
$107 USD

selinc.com/products/TR

The SEL-TR is ideal for underground systems that do not provide sufficient voltage or current to reset and arm a faulted circuit indicator (FCI). The SEL-TR holds its tripped status indication for a set time, regardless of the presence of current or voltage on the distribution circuit. You can use this functionality for applications where backfeed voltage or current can falsely reset restoration-reset FCIs in the fault path. The 1 ms trip response time and time-based reset feature make SEL-TRs a great fit for momentary fault-locating applications. The SEL-TR is available with a long-lasting nonreplaceable battery for installations that require zero maintenance.

REMOTE DISPLAY OPTIONS

UNDERGROUND FAULT INDICATORS

Choose from a variety of display options, including nonbattery mechanical flag displays and bright BEACON® LED displays.

Remote displays eliminate the need for crews to open high-voltage enclosures or enter subsurface vaults, improving fault-finding times and reducing arc-flash risks.

Standard "V" Display (BEACON versions also available)

Large "L" Display (BEACON versions also available)

BEACON Bolt® Display

Tamperproof Bolt Display

BEACON Fiber-Optic Display

SEL-8310 RadioRANGER® Remote Fault Reader

ACCESSORIES AND TOOLS

Starting Price
$36 USD

SEL-MR Manual Reset Fault Indicator
Troubleshoot overhead and underground applications.

Starting Price
$43 USD

SEL-MR Manual Reset Fault Indicator With Reset Button
Troubleshoot underground applications.

Starting Price
$60 USD

MT Manual Reset Tool
Reset the SEL-MR.

Starting Price
$206 USD

SEL-FC Overhead Fault Counter Fault Indicator
Narrow down the source of intermittent, hard-to-find temporary or permanent faults on overhead circuits.

Starting Price
$250 USD

FCRT Fault Counter Reset Tool
Reset an SEL-FC without removing it from the line.

Starting Price
$37 USD

SEL-VIN Voltage Indicator
Install this line-powered tool on test point elbows, T-bodies, or basic insulating plugs to indicate the presence of voltage.

Starting Price
$60 USD

HHT Silver Tamperproof Bolt Test Tool
Determine the status (tripped or untripped) of fault indicators with tamperproof bolt displays.

Starting Price
$30 USD

BTT BEACON Bolt® Test Tool
Field-test fault indicators with BEACON Bolt displays.

Starting Price
$50 USD

CRSRTT Current and Secondary Reset Test Tool
Field-test and manually reset the SEL-AR, SEL-ARU, SEL-BTRI, and other current reset and timed-reset products.

Starting Price
$50 USD

ERLTT Electric Field Reset Test Tool
Field-test the SEL-ER Overhead Electrostatic Reset Fault Indicator.

Starting Price
$300 USD

MCL120 Mini Current Loop
Use the MCL120 for demonstration purposes or to trip or reset fault indicators.

Starting Price
$6 USD

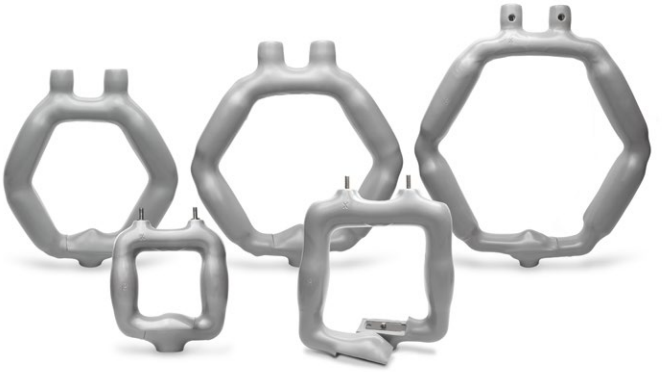
SEL-MCG Magnetic Cable Guide
Keep remote display and sensor cables neat and secure.

SEL-CT

SPLIT-CORE CURRENT TRANSFORMER

Starting Price
$141 USD

selinc.com/products/CT



SEL-CTs are designed for applications where it is difficult or uneconomical to open the primary conductor to install a solid-core-type current transformer. The flexible split-core design uses M-6 silicon steel formed into a hexagonal or rectangular shape. This allows you to open the core to install it over cables.

The SEL-CT is encapsulated in a flexible vinyl plastic with 600 V-class insulation. The secondary terminals and hardware are nickel-plated brass.

Volume pricing is available.

SEL-SCT

SUBMERSIBLE SEPARABLE-CORE CURRENT TRANSFORMER

Starting Price
$172 USD

selinc.com/products/SCT

SEL-SCTs are designed for applications where it is difficult or uneconomical to open the primary conductor to install a solid-core-type CT. The separable-core design allows you to open the SEL-SCT to the nominal window diameter and install it over bushings or cables without interrupting the connection. SEL-SCTs are held in place with cable ties. The submersible design provides reliable use in subsurface vaults where flooding can occur.

The SEL-SCT is encapsulated in flexible vinyl plastic with 600 V-class insulation and consists of a separable two-part assembly. The SEL-SCT base and body can be pulled apart, placed around a cable, and reconnected. Two included stainless-steel worm gear clamps secure the base and body of the CT while also preventing water intrusion into the CT core.

Volume pricing is available.

METERING OVERVIEW

SEL-735 POWER QUALITY AND REVENUE METER

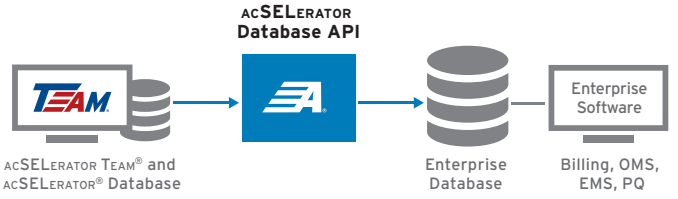
Achieve high-accuracy revenue and power quality metering for any application. The SEL-735 offers 1 GB of recording memory for up to 20 years of storage and is now available with a color touchscreen display. Multiple enclosure and mounting options are available.

METER INSTALLATION OPTIONS AND ACCESSORIES

Mount SEL meters and accessory devices into a variety of locations using a complete line of mounting kits. You can choose from rack-mount, wall-mount, indoor, or outdoor configurations.

ACSELERATOR METER REPORTS

Transform metering data into action with ACSELERATOR® Meter Reports SEL-5630 Software. The software offers interactive charts, fast database interrogation, and the ability to customize metering reports for utilities, industrial operations, and site-wide campus monitoring.



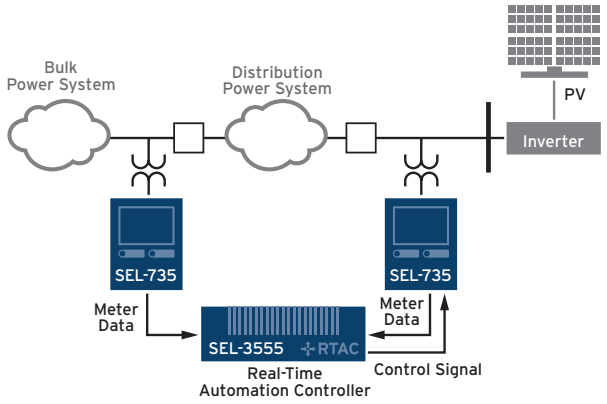
ACSELERATOR DATABASE API

Allow third-party systems to access ACSELERATOR TEAM® SEL-5045 Software data with the SEL-5230 ACSELERATOR Database API. This allows different enterprise-level systems, such as an energy management system or a billing system, to integrate data reporting.

SEL-735 POWER QUALITY OPTIONS	BASIC	INTERMEDIATE	ADVANCED
GENERAL			
Display	Customizable three-line or single-line display	Customizable three-line or single-line display	Customizable three-line or single-line display; 5-inch, 800 × 480 color touchscreen display*
Type-C USB Front Port	No	No	Yes*
Memory	128 MB	256 MB	1 GB
Maximum Harmonic Order	15th	63rd	63rd
Interharmonic Quantities	No	No	Yes
Harmonic Angles	No	No	Yes
Power Harmonics	No	No	Yes
Portable Case	No	No	Yes*
WAVEFORM CAPTURE			
Samples Per Cycle	16	16, 128	16, 128, 512
Duration (Cycles)	15	15–600	15–600
Number of Events	256	33–6,200	101–10,000
COMTRADE Reports	Yes	Yes	Yes
Wave View Oscillography	No	No	Yes
LOAD PROFILE DATA			
Recorders × Channels	1 × 16	12 × 16	32 × 16
Acquisition Rates	1–120 min	3–59 s, 1–120 min	3–59 s, 1–120 min
Storage Duration for 10-Minute Interval Data			
16 Channels	10 years	20 years	20 years
192 Channels	N/A	1.5 years	9.5 years
512 Channels	N/A	N/A	3.5 years
VOLTAGE SAG, SWELL, AND INTERRUPTION (VSSI) RECORDER			
Typical Number of Summary Events	260	260	600
Number of Detailed Rows	60,000	60,000	130,000
Minimum Disturbance Duration	1/4 cycle	1/4 cycle	1/4 cycle
Sampling Rate	4 samples/cycle; 1 sample/day, adaptive	4 samples/cycle; 1 sample/day, adaptive	4 samples/cycle; 1 sample/day, adaptive
SEQUENTIAL EVENTS RECORDER (SER)			
Number of Events	>80,000	>80,000	>80,000
Number of Channels Monitored	≤72	≤72	≤72
IEC 61000-4-30 POWER QUALITY COMPLIANCE			
150/180-Cycle, 10-Minute, 2-Hour Aggregation	–	Class A	Class A
Flicker	–	Class A (10 min, 2 hr updates)	Class A (1 min, 10 min, 2 hr updates)
Voltage Harmonics	Class A	Class A	Class A
Harmonic Currents	Class A	Class A	Class A

*Optional feature

METERING APPLICATIONS

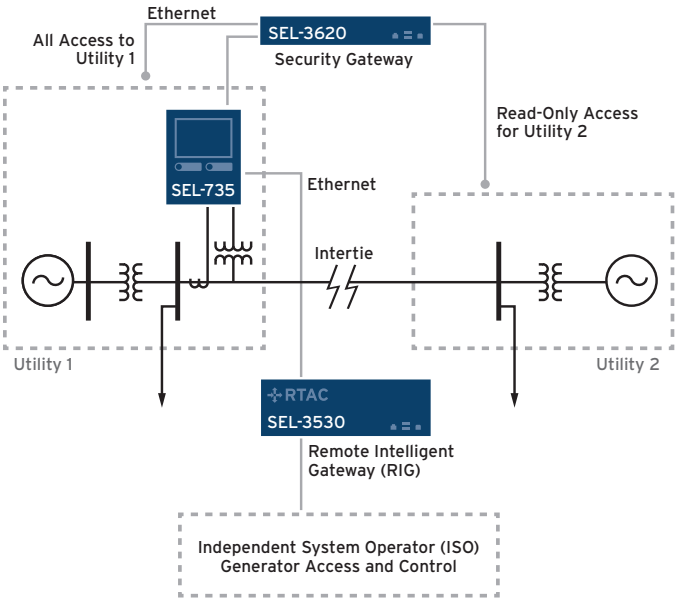


IMPROVE GRID OPERATION

Improve reliability and enhance the integration of variable resources into the bulk power system. Meters installed at renewable energy generation points provide fast streams of accurate synchrophasor data to the system operator.

The SEL-735 Power Quality and Revenue Meter includes the latest version of the synchrophasor standard, IEEE C37.118-2014 Class P, making it ideal for applications requiring fast response times under dynamic conditions.

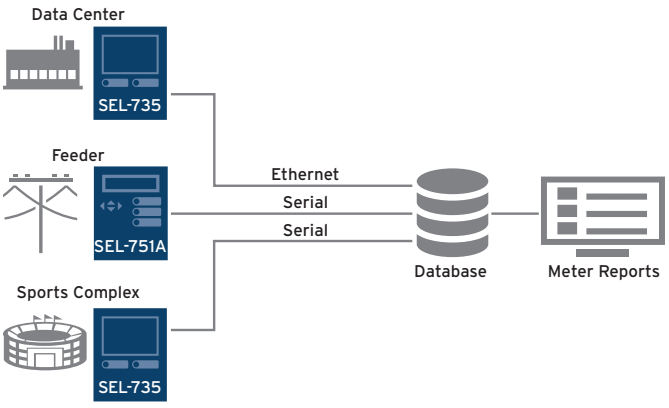
As part of a NERC PRC-002 disturbance monitoring system, you can connect the SEL-735 to SEL-5073 SYNCHROWAVE® Phasor Data Concentrator (PDC) Software. This lets you distinguish between utility outages and transient disturbances to quickly choose when to island the system.



COMMUNICATE INTERTIE AND GENERATION DATA SECURELY

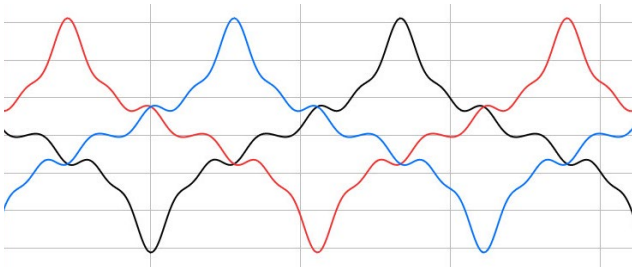
Share intertie data and limit privileges to read-only access using the SEL-3620 Ethernet Security Gateway. Alternatively, you can choose the SEL Remote Intelligent Gateway (RIG) solution for read and control access. The SEL-3530 Real-Time Automation Controller (RTAC) allows the independent system operator (ISO) access to plant information for generation control.

The SEL-735 provides uninterrupted information access with up to ten simultaneous communications sessions. Advanced communications deliver critical and historical information in real time to virtually any communications system. Cryptographically signed firmware ensures that the meter integrity is not compromised.



AUTOMATE DATA COLLECTION

Automate data collection and improve efficiency by eliminating the need to collect data from field devices manually. To streamline the process, ACSELERATOR TEAM® SEL-5045 Software identifies new reports, downloads them, and stores the information. TEAM collects event reports; Sequential Events Recorder (SER) data; voltage sag, swell, and interruption (VSSI) data; and load profile data for historical analysis. After TEAM gathers and stores the data from the metering devices, ACSELERATOR® Meter Reports SEL-5630 Software displays the information to help you make planning, operating, and accounting decisions that will increase efficiency and reduce costs. With the ACSELERATOR Database API, third-party software tools can access metering data and use the data in different enterprise-level systems, such as an energy management system or a billing system.



Voltage Waveform	Current Waveform	0.1 Class Allowable Error %	Measured SEL-735 Error %
Sinusoidal	Sinusoidal	±0.05	0.003
Sinusoidal	Peaked	±0.2	0.006
Peaked	Peaked	±0.3	0.006

REVENUE METERING

Achieve high-accuracy revenue metering under real-world power quality conditions. The SEL-735 exceeds the ANSI C12.20-2015 0.1 accuracy class and the IEC 62053-22 0.2 accuracy class over a wide current range.

The SEL-735 accurately reports energy even in the presence of harmonics and distorted waveforms. When tested with peaked waveform distortion, the SEL-735 reports with an error of just 0.006%. The table shows SEL-735 performance with peaked waveform distortion.

REDUCE SYSTEM DOWNTIME

Access critical information directly at the control center with SCADA-ready SEL meters. Reports with VSSI data and events plotted on the ITI (CBEMA) chart can help both plant operators and power producers resolve issues before they affect consumers. The ITI curve classifies voltage events to indicate disturbance severities that cause malfunctions, such as insulation failure, overvoltage trip, or load dropout. The SER in SEL devices monitors and records device events, such as power loss, settings changes, voltage disturbances, or any change in the state of digital status bits. Wave View, a near real-time oscillography tool in the SEL-735, gives system operators a snapshot of their system for actionable intelligence.

SEL-735

POWER QUALITY AND REVENUE METER

Starting Price
$1,500 USD

selinc.com/products/735

Select models typically ship in 2 days

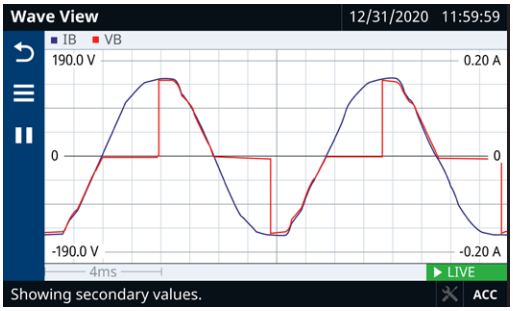
The SEL-735 is fully Class A-compliant to the IEC 61000-4-30 power quality (PQ) standard. With reliable Class A measurement, operators can identify power system anomalies and isolate their source with confidence. The 5-inch, 800 × 480 color touchscreen display option allows you to view metered quantities, phasor diagrams, voltage and current waveforms, and more. For high-accuracy revenue metering applications, the SEL-735 exceeds ANSI C12.20-2015 0.1 and IEC 62053-22:2003 0.2 accuracy class requirements over a wide current range. This makes the SEL-735 the premiere choice for generation, interchange, transmission, distribution, or industrial applications. You can enhance the capabilities of SEL meters with ACSELERATOR® Meter Reports SEL-5630 Software. Meter Reports allows you to optimize your system by analyzing data, identifying usage trends, and diagnosing system problems.

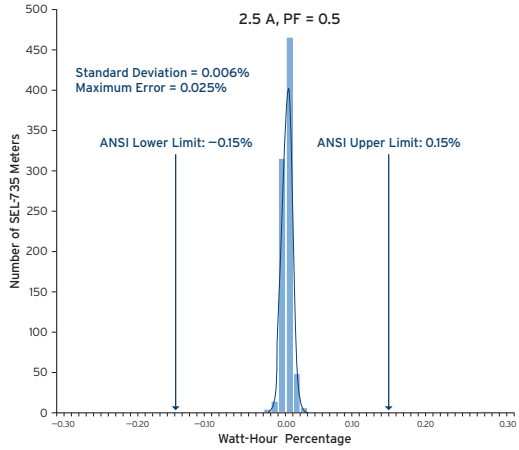
Ensure Accurate Revenue Metering—Exceed ANSI C12.20 0.1 and IEC 62053-22 0.2 accuracy class requirements with bidirectional, full four-quadrant energy metering. Transformer/line-loss compensation adds to meter accuracy when the meter location and billing points differ. Instrument transformer compensation removes the magnitude and phase error introduced by CTs and PTs.

Measure and Report Reliable PQ Indicators—Ensure precise and reliable measurements with IEC 61000-4-30 Class A PQ compliance. You can size feeders appropriately, safeguard equipment, and plan upgrades using PQ indicators for predictive maintenance. The SEL-735 measures harmonics, interharmonics, flicker, power factor, voltage disturbances, K-factor, and other key PQ indicators.

Other popular applications include troubleshooting voltage disturbances, monitoring photovoltaic (PV) inverter interconnections, and monitoring sine wave purity for critical industrial facilities. The SEL-735 allows you to quickly identify PQ problems before equipment damage or misoperation occurs.

Wave View—SEL-735 Meters with the Advanced PQ and Recording option include the Wave View monitoring tool in the ACSELERATOR QuickSet® SEL-5030 HMI. The tool is also available via the optional touchscreen display. Wave View allows you to view voltage and current waveforms in near real time using an oscilloscope-like functionality. Waveforms in Wave View can be viewed immediately without having to retrieve and import files. The HMI provides the time-domain display as well as the frequency spectrum of any waveform captured.





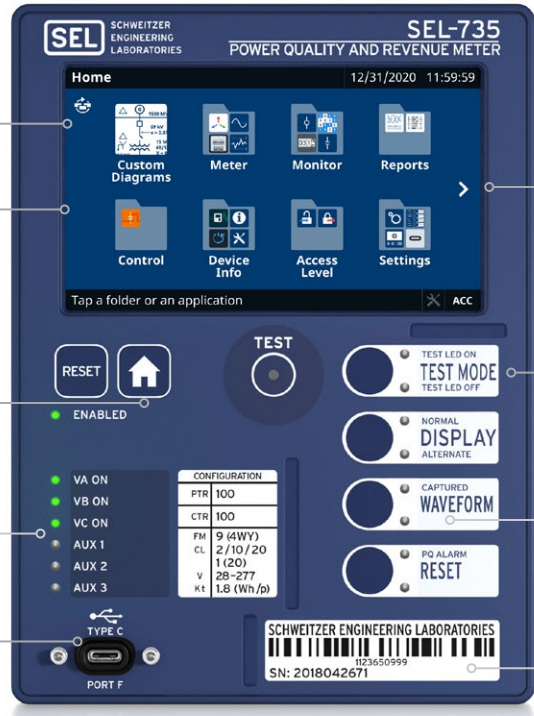
Accuracy-test results of approximately 1,000 SEL-735 Meters report a maximum error of 0.025 percent, outperforming ANSI 0.1 and IEC 0.2 accuracy class requirements.

Advanced Integration—The SEL-735 integrates seamlessly with Itron MV-90 billing software and IEC 61850, DNP3, IEEE C37.118-2014, Modbus, or SEL communications protocols. Multiple communications ports and protocols enable the SEL-735 to simultaneously communicate with up to ten devices.

The SEL-735 offers three security levels to provide access to only authorized users. In addition, you can independently disable or set each port to provide read-only or read/write access.

For system-level security, adding the SEL-3620 Ethernet Security Gateway offers user account management, substation firewall protection, and NERC CIP compliance support. The SEL Real-Time Automation Controller (RTAC) provides secure, encrypted communications and works as a remote intelligence gateway. Cryptographically signed firmware ensures that the meter integrity is not compromised.

SEL-735 OVERVIEW



Capacitive 5-inch, 800 × 480 color touchscreen

Full onscreen keyboard

Pushbutton to return to default home screen

Six programmable LEDs

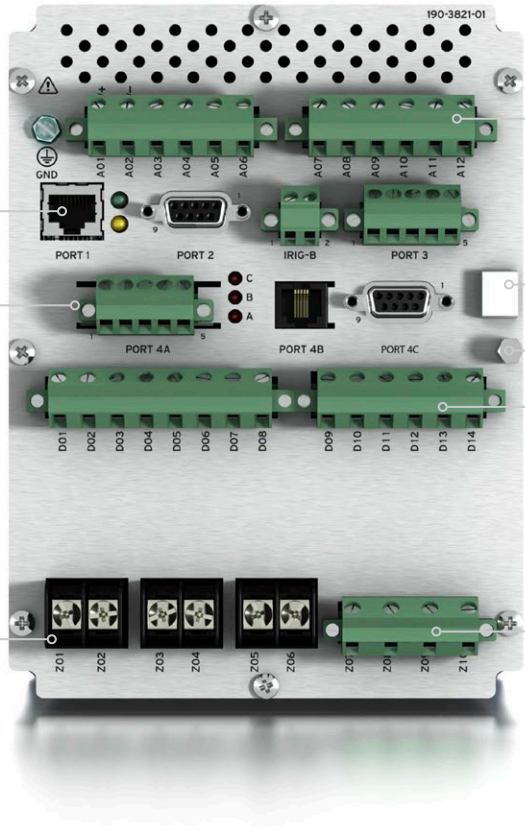
USB Type-C port

Folders and applications to access information

Simple test-mode access

Customizable local controls

Custom nameplate and barcode



Main board: RJ45 copper or fiber-optic Ethernet, EIA-232, IRIG-B, EIA-232/-485

Communications board (Expansion Slot #1): EIA-485, telephone modem, EIA-232

CT board: Ia, Ib, Ic

Power supply board: 2 inputs, 3 outputs

Sealing provision

I/O board (Expansion Slot #2): 4 inputs, 4 outputs (solid-state or electromechanical); or 4 analog outputs, 4 solid-state outputs

PT board: Va, Vb, Vc, Vn

SEL-5630

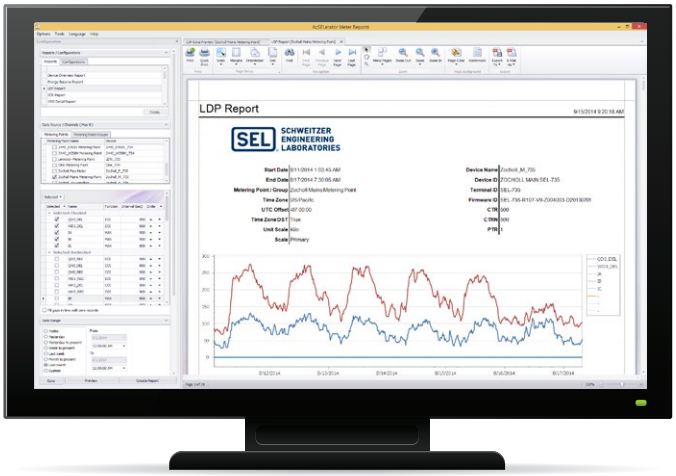
ACSELERATOR® METER REPORTS SOFTWARE

Starting Price

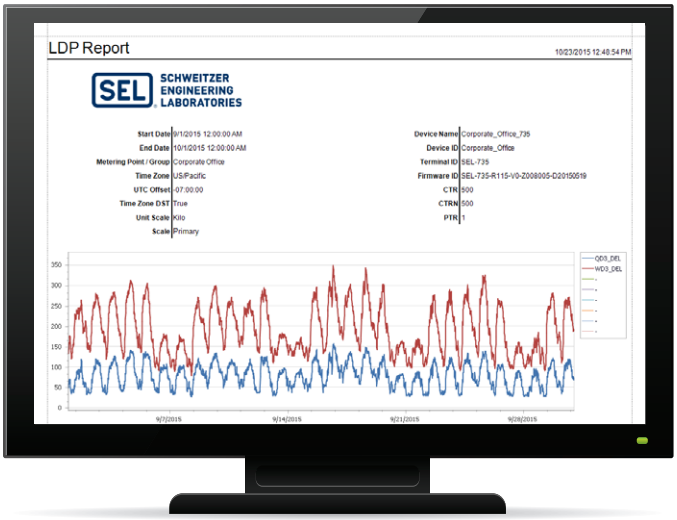
$2,500 USD

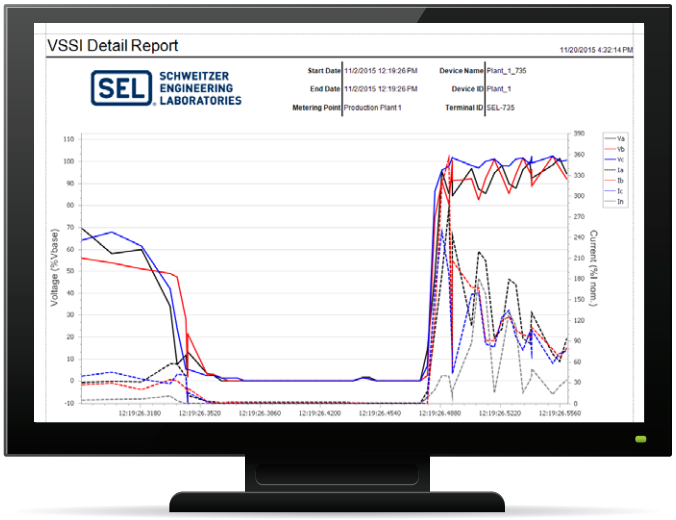
Requires ACSELERATOR TEAM® SEL-5045 Software for meter data collection.

selinc.com/products/5630



Meter Reports enhances the visualization and analysis of data captured by SEL meters in your system. You can combine SEL meters with pulse-type or DNP3-enabled devices to monitor consumption of resources, such as water, air, gas, and steam. ACSELERATOR TEAM SEL-5045 Software automatically retrieves and stores metering data on these resources in a centralized database. Meter Reports then displays the information so you can drive planning, operating, and accounting decisions that will increase efficiency and reduce costs.





LOAD DATA PROFILE (LDP) REPORT

Avoid peak demands by analyzing the electrical usage for processes in your facility. An interactive view of the information lets you refine the LDP data selection for a specified time period. You can create a report or hover your mouse over data points to view channel values at that point in time. Graphical and tabular views of LDP information from a metering point, device, or group make it easy to analyze trends and inspect records.

VSSI DETAIL REPORT

Investigate power quality events with voltage sag, swell, and interruption (VSSI) data at your fingertips. You can perform VSSI event analysis with detailed VSSI data (using variable sampling rate records) in graphical and tabular format. The 4 ms resolution makes it easy to identify points of interest and determine the time, duration, severity, and location of power quality disturbances.

SEL-5230

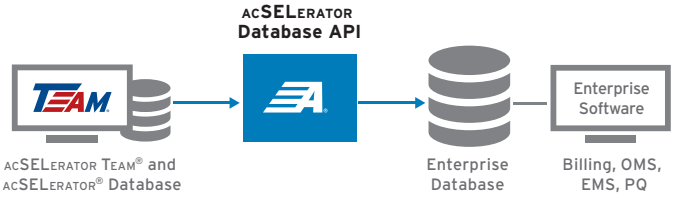
ACSELERATOR® DATABASE API

Starting Price

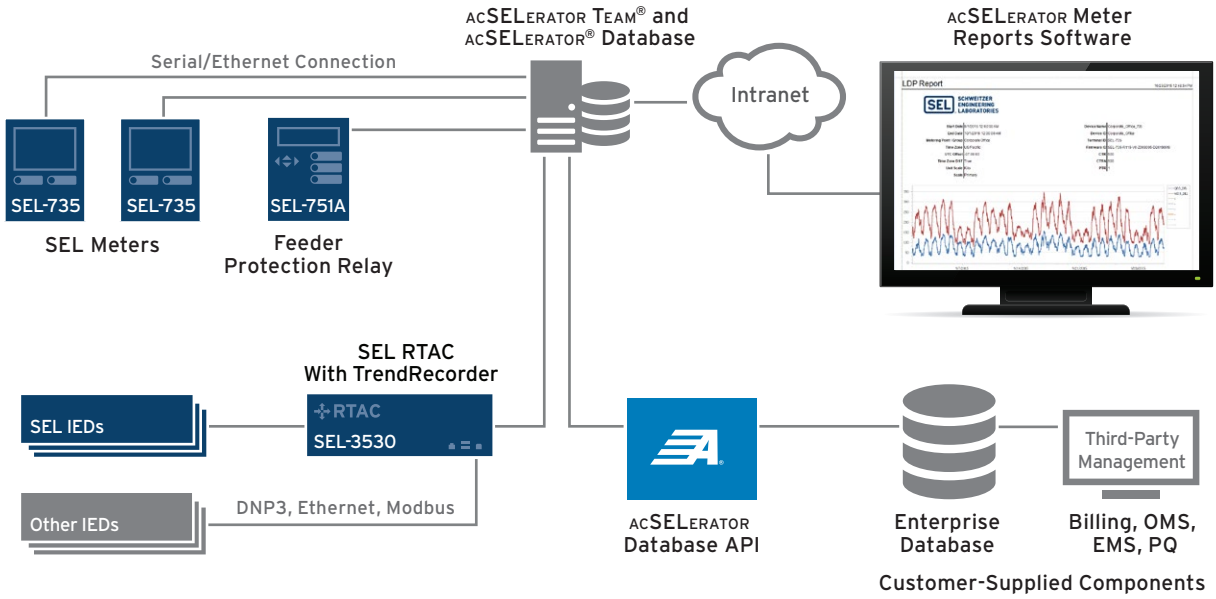
$5,000 USD

Requires ACSELERATOR TEAM® SEL-5045 Software for meter data collection.

selinc.com/products/5230



ACSELERATOR Database API SEL-5230 Software provides third-party software tools with access to data collected by ACSELERATOR TEAM SEL-5045 Software and archived in the ACSELERATOR Database. This allows different enterprise-level systems, such as an energy management system (EMS) or a billing system, to integrate data reporting. SEL offers two API configuration options, depending on the database integration and client requirements.



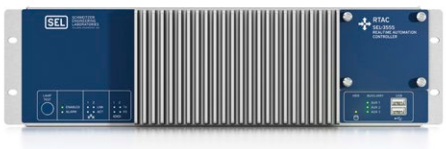
ACSELERATOR TEAM SOFTWARE

TEAM automates the collection of power system data from multiple devices and stores the data in a central location for easy access. When something happens, whether it's a relay trip, system fault, or security notification, TEAM is ready to help with continuous background monitoring, collection, notification, and storage. This ensures that the data are there when you need them to help discover root cause, maintain records for regulatory compliance, and keep your system running at peak efficiency.

AUTOMATION CONTROL OVERVIEW

SEL-3530/3530-4 RTACs

Complete and flexible system control with integrated security, seam-less configuration, unified logic, and high reliability.



SEL-3555 RTAC

Powerful computing (55 times faster than other RTACs) for large-scale automation projects.

SEL-3505/3505-3 RTACs

Powerful automation, reporting, and control for low-power, limited-space applications.

SEL-3560E/3560S RTACs NEW

Fast processing (55 times faster than other RTACs) in a compact form factor.

SEL-2240 AXION®

A fully integrated, modular I/O and control solution for utility and industrial applications.

SEL-2411P

Reliable pump automation control with a SCADA-ready solution that is easy to install, set, and customize.

SEL-2440

Utility-grade I/O, powerful processing, flexible communications, and microsecond timing.

SEL-2411

Flexible I/O for automatic control, SCADA, station integration, remote monitoring, and plant control systems.

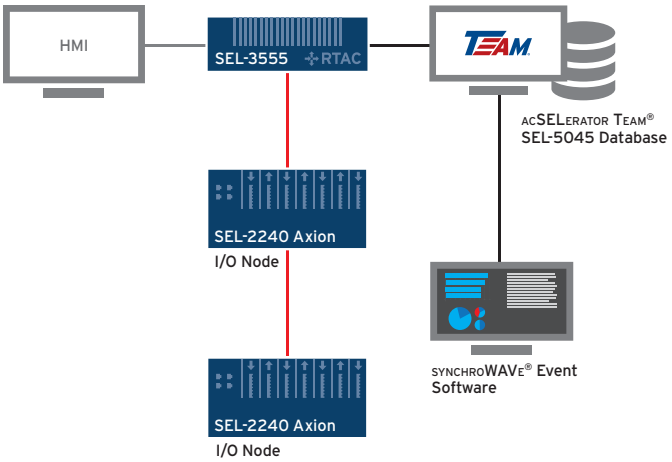
SEL-3573

Connection to any IEEE C37.118-compliant phasor measurement unit (PMU) or client.

	SEL-3555/3560E/3560S	SEL-3530	SEL-3530-4	SEL-2240	SEL-3505/3505-3	SEL-3532/3533	SEL-2032	SEL-2411	SEL-2411P	SEL-2440
APPLICATIONS										
Collect, Scale Meter Data	•	•	•	•	•	•	•	•	•	
Collect Targets, Contact Input Status, Fault Location	•	•	•	•	•	•	•	•	•	•
Enable Fiber-Optic Links	•	•	•	•	•	•	•	•	•	•
Control Through IED Outputs	•	•	•	•	•	•	•			
Accept and Provide IRIG-B Time Synchronization	•	•	•	•	•	+	•			
Concentrate IED Data For:										
Distributed Control System (DCS)	•	•	•	•	•	•	•			
SCADA Master or Remote Terminal Unit (RTU)	•	•	•	•	•	•	•			
Local or Remote HMI	•	•	•	•	•	•	•			
Transparent "Port Switch"	•	•	•	•	•	•	•	•	•	•
Web Server HMI	+	+	+	+		+				
FEATURES										
Protocol Redundancy (DNP3 and IEC 60870-5 101/104 Server)	•	•	•	•	•	•				
Primary and Standby LAN Support	•	•	•	•	•	•	•[1,2]	•	•	•
Optoisolated Inputs/Programmable Outputs	•[3]	+	•	+	+	•[3]	+	+	+	+
Rack-Mount or Panel-Mount Hardware	•[4]	+	+	+		•	+	+	+	+
IEC 61131 Logic Engine	•	•	•	•	•	•				
Cybersecurity Management	•	•	•	•	•	•				
Real-Time Operating System	•	•	•	•	•	•	•	•	•	•
SERIAL PORT PROTOCOLS										
SEL Mirrored Bits® Communications	•	•	•	•	•	•		•	•	•
Client										
DNP3	•	•	•	•	•	•				
Modbus RTU	•	•	•	•	•	•				
LG 8979	•	•	•	•	•	•				
CP 2179	•	•	•	•	•	•	•			
SEL Fast Messages, Interleaved With ASCII	•	•	•	•	•	•	•			
SEL Synchrophasors	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ	+			
IEC 60870-5 101	•	•	•	•	•	•				
SES-92	•	•	•	•	•	•				
ASCII Flex Parse	•	•	•	•	•	•				
Server										
DNP3	•	•	•	•	•	•	•	+	•	+
Modbus RTU Binary	•	•	•	•	•	•	•	•	•	•
IEC 60870-5-101	•	•	•	•	•	•				
LG 8979	•	•	•	•	•	•				
SES-92	•	•	•	•	•	•				
NETWORK PROTOCOLS										
Telnet	•	•	•	•	•	•	•[1]	•	•	•
FTP							•[1]	•	•	•
DNP3 LAN/WAN Client/Server	•	•	•	•	•	•	•[1]	+	•	+
Modbus TCP	•	•	•	•	•	•		•	•	•
IEC 61850/UCA2							•[1]			
IEC 61850 MMS Client/Server	+	+	+	+	+	+		+		+
IEC 61850 GOOSE	+	+	+	+	+	+		+		+
IEC 60870-5-104 Client/Server	•	•	•	•	•	•				
IEEE C37.118 Client/Server	•	•	•	•	•	•				
Flex Parse	•	•	•	•	•	•				
FTP/SFTP Client/Server	•	•	•	•	•	•				
SNMP Client/CDC Type 2 Client/Server	•									
Lightweight Directory Access Protocol (LDAP)	•	•	•	•	•	•				
EtherCAT®	•[5]	•	•	•	•	•				
EtherCAT/IP	•[5]	•	•	•	•	•				
Precision Time Protocol (PTP)/Network Time Protocol (NTP)	•	•	•	•	•	•				
Simple Network Time Protocol (SNTP)	•	•	•	•	•	•		•	•	•
Parallel Redundancy Protocol (PRP)	•	•	•	•	•	•		•	•	•

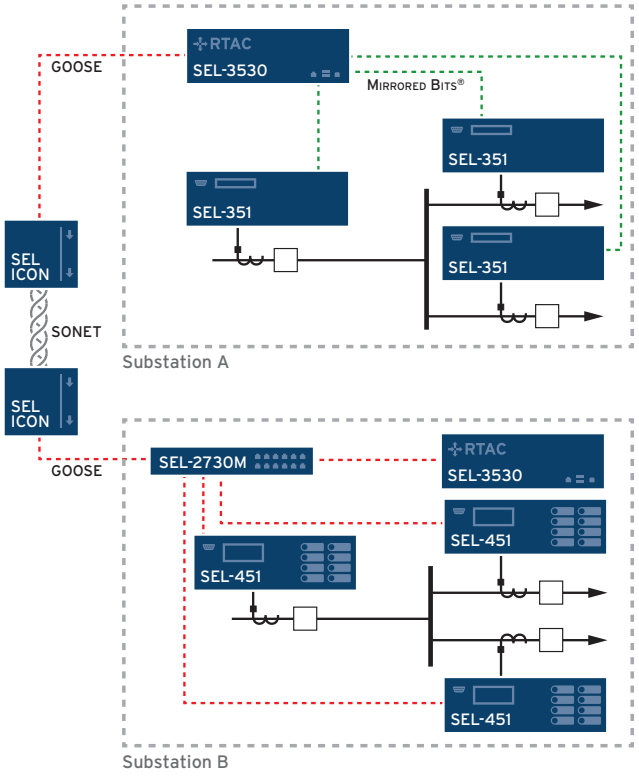
• Standard feature
+ Model option
ƒ May be created using settings
[1]With Ethernet option
[2]With Modbus Plus option
[3]Alarm contact only
[4]SEL-3560E/3560S are surface-mount only
[5]Not supported on SEL-3560S

AUTOMATION CONTROL APPLICATIONS



DYNAMIC DISTURBANCE AND FAULT RECORDING SYSTEMS

Use the SEL-3555 Real-Time Automation Controller (RTAC) with SEL-2240 Axion® modules to develop advanced recording solutions that exceed NERC PRC-002 requirements. The SEL-2245-42 AC Protection Module features 24 kHz recording with recording group configuration for combining multiple module event reports, including digital values, into a single COMTRADE file. The SEL-3555 RTAC with SSD storage is the perfect controller for recording applications to maintain more than the minimum ten-day storage requirement of all fault, dynamic disturbance, and Sequence of Events records in the substation.



POWER SYSTEM AUTOMATION

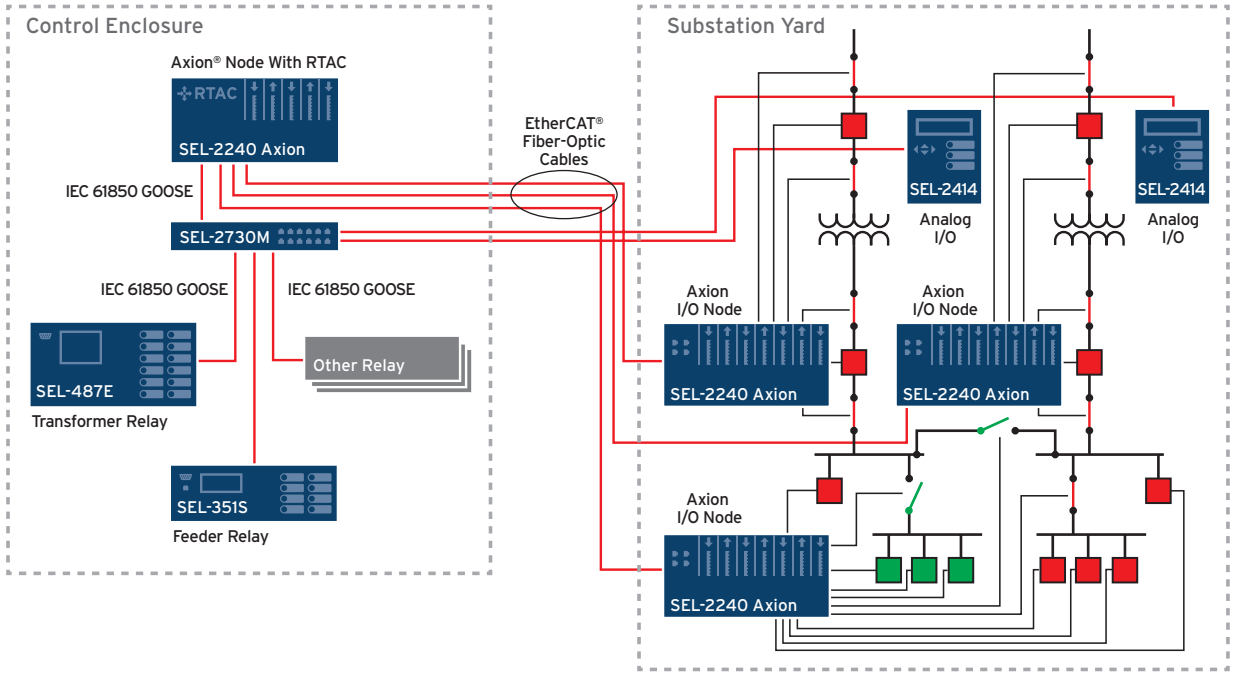
Enable high-performance control and monitoring schemes. The SEL RTAC provides a bridge between MIRRORED BITS® communications and IEC 61850 GOOSE networks. Protection applications include directional element-based bus protection and replacement of tone-channel equipment for communications-assisted blocking, unblocking, permissive, and transfer trip schemes.

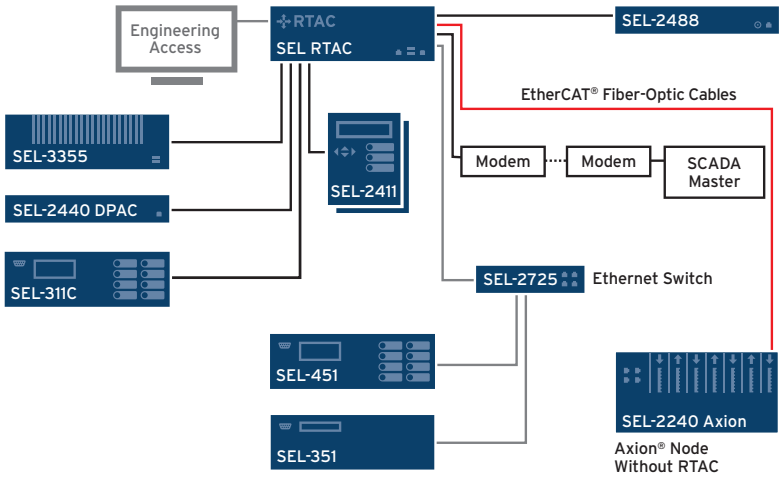
SUBSTATION HMI

Provide cost-effective local and remote monitoring and control for substations and other processes by installing the optional web-based HMI, available for the RTAC and Axion. ACSELERATOR Diagram Builder™ SEL-5035 Software easily maps the RTAC tag database to reduce screen development time. You can use the integrated video port of the SEL-3555 RTAC for local display of the HMI without relying on a separate computer.

SUBSTATION AUTOMATION

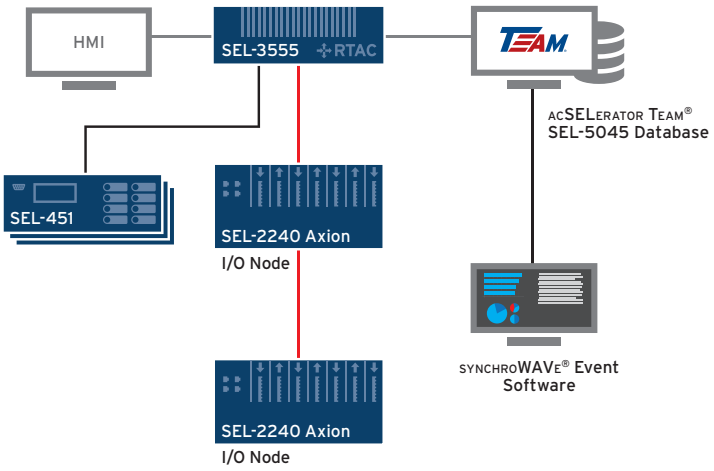
Use the Axion to integrate substation I/O into a comprehensive substation control scheme that includes IEC 61850 GOOSE messaging. Connecting enclosures and substation yards with EtherCAT® fiber-optic cables offers signal isolation and flexible modular placement.





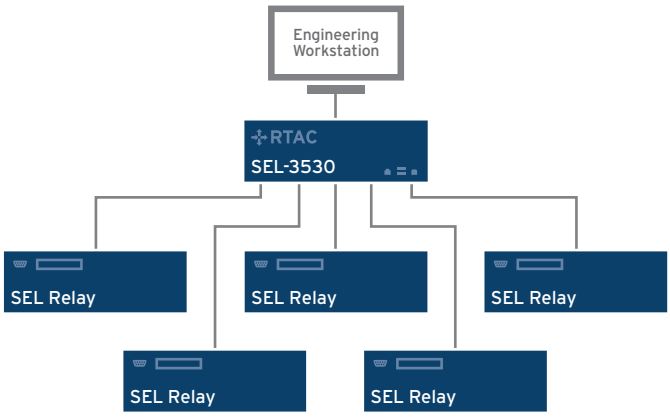
DATA CONCENTRATION AND SCADA

Deploy the RTAC as a data concentrator using protocols such as IEC 61850, Manufacturing Message Specification (MMS), Modbus, DNP3, IEC 61850 GOOSE, LG 8979, IEC 60870-5-101/104, or MIRRORED BITS communications, and integrate both serial and Ethernet IEDs. By enabling logging on any system or IED tag, you can view and archive station-wide event records. Multiple SCADA connections are possible via serial or Ethernet communications.



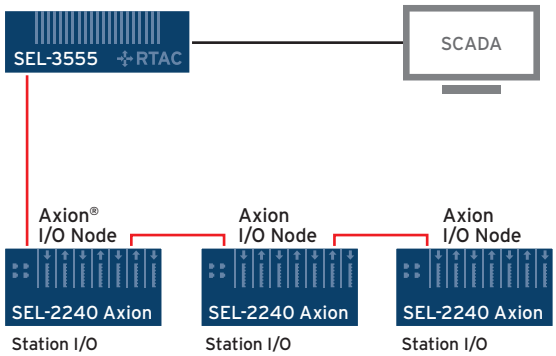
AUTOMATIC COLLECTION OF FAULT OSCILLOGRAPHY AND SEQUENCE OF EVENTS DATA

Meet and exceed the requirements of NERC PRC-002 using the SEL-3555 RTAC to collect dynamic disturbance records, fault records, and event reports from relays. The SEL-3555 RTAC serves as the main controller and storage device (up to 480 GB SSD) for the ten-day minimum storage requirement in the substation. You can configure automatic retrieval of these data by using ACSELERATOR TEAM® SEL-5045 Software, Secure File Transfer Protocol (SFTP), or MMS file services.



ENGINEERING ACCESS

Securely gain remote access to the RTAC and connected devices via Ethernet to configure IEDs, monitor logs, and analyze diagnostics. Engineering access channels in the RTAC enable remote connections to devices using serial or Ethernet communications. The Lightweight Directory Access Protocol (LDAP) provides centralized user authentication and access control.

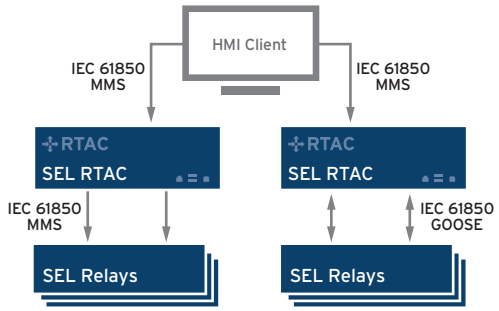


HIGH-SPEED FAULT RECORDING WITH AXION I/O

Customize fault recording by choosing from 1 to 24 kHz reports ranging from 1 to 560 seconds. You can store up to 1,024 COMTRADE reports.

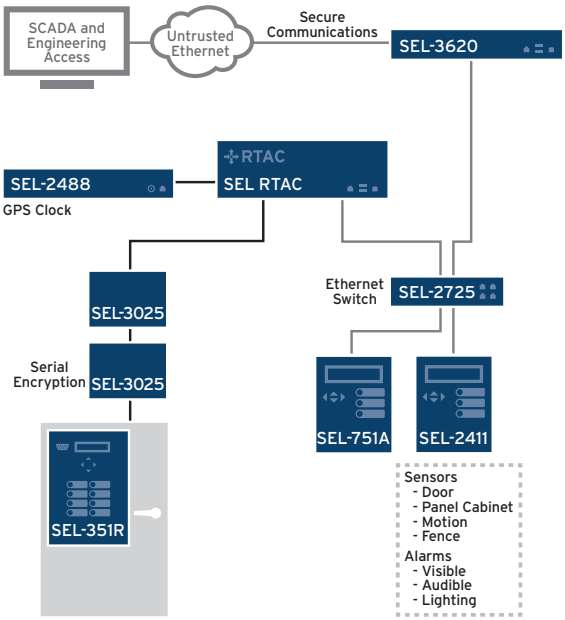
Use the advanced SEL logic engine in the Axion to trigger events. You can cross-trigger other digital fault recorder (DFR) systems or relays using IEC 61850 GOOSE messages or MIRRORED BITS communications.

Use SYNCHROWAVE® Event Viewer to perform detailed analysis, like Fast Fourier Transform and spectral analysis, to find harmonic content in the power system.



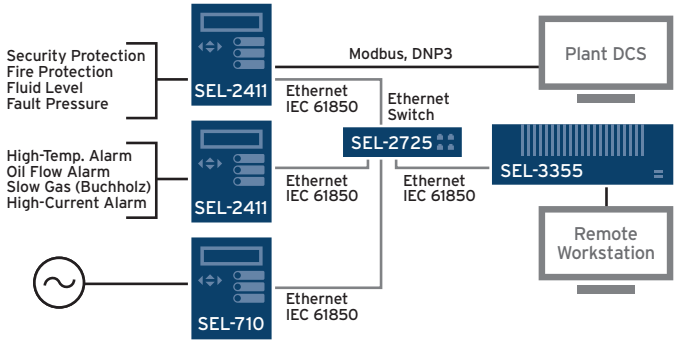
IEC 61850 SYSTEM

Implement the RTAC as a central controller in an IEC 61850 system with IEC 61850 GOOSE and MMS protocols. With IEC 61850 Edition 1 and 2 support, the RTAC easily integrates with new and existing infrastructure. You can collect data from legacy protocols and convert them to MMS using the RTAC's MMS server.



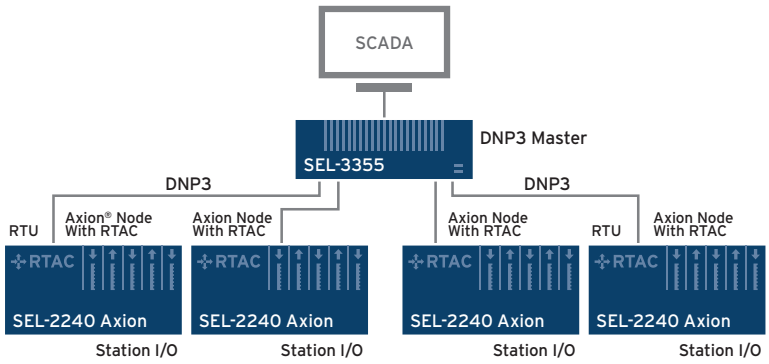
SECURE COMMUNICATIONS AND USER MANAGEMENT

Employ the RTAC, SEL-3620 Ethernet Security Gateway, and SEL accessories to secure your automation network. Per-user security profiles comply with role-based requirements. The system supports intrusion detection, notification, and logging to help maintain perimeter integrity. Secure Shell (SSH) provides encrypted engineering access through the RTAC.



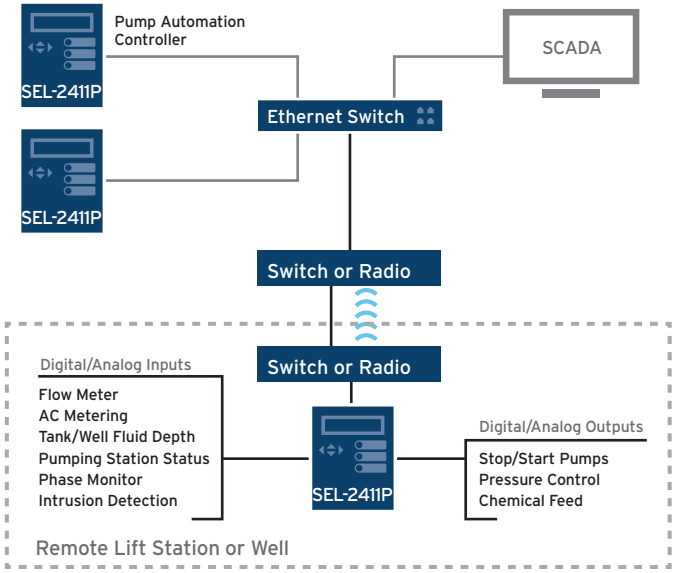
INDUSTRIAL PLANT MONITORING

Implement automatic control or data acquisition using high-speed, deterministic logic capabilities available in SEL processors and controllers. Input cards let you collect temperature, fluid level, pressure, and valve position data from sensors.



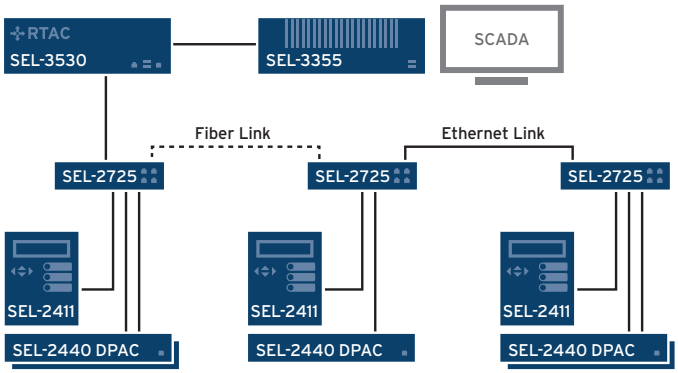
SUBSTATION REMOTE TERMINAL UNIT (RTU)

Gather digital and analog signals from remote sites with the Axion, and distribute the data over a variety of industry-standard protocols to a central SCADA system or HMI.



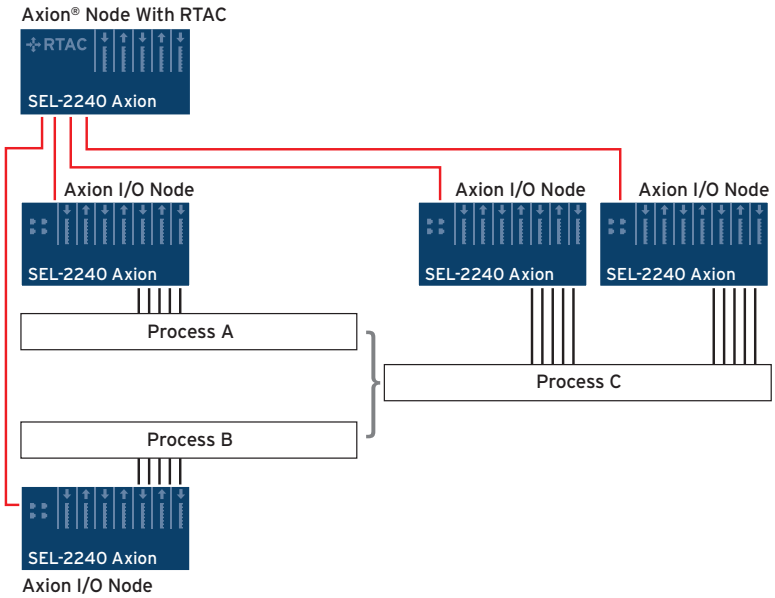
PUMP CONTROL AND MONITORING

Manage fluid levels, pump operations, and pump house security with the SEL-2411P Pump Automation Controller. You can coordinate control and monitoring for wells, lift stations, booster stations, or RTUs through wired and wireless communications technologies.



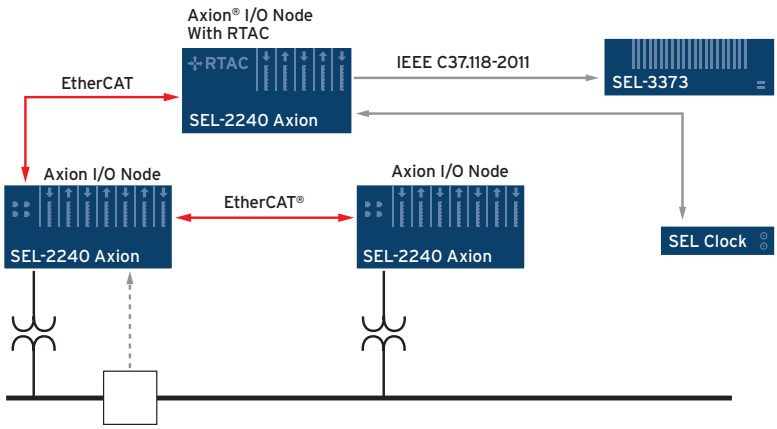
DISTRIBUTED I/O MONITORING

Measure analog currents, voltages, or the status of contact points with SEL automation controllers. You can use the data locally within the device, send the information to another device within the substation, or send the information to one or more databases for operators, engineers, planners, and administrators.



PROCESS AND PROPORTIONAL INTEGRAL DERIVATIVE (PID) CONTROL

Implement sequential control schemes, enable continuous control algorithms, and monitor critical processes throughout an operating facility with the Axion. You can also apply advanced PID control libraries to dynamic system processes.



FLEXIBLE PHASOR MEASUREMENT UNIT (PMU)

Apply the Axion as a scalable and distributable synchrophasor measurement system. A single RTAC processor in the primary Axion node serves IEEE C37.118.1a-2014 synchrophasor data from remote Axion nodes. Remote Axion nodes use the SEL-2245-4 AC Metering Module located at the measurement points.

REAL-TIME AUTOMATION CONTROLLERS (RTACs)

SEL-3555/3530/3530-4/3505/3505-3/3560

Starting Price

SEL-3555: $7,295 USD — selinc.com/products/3555
SEL-3530: $4,500 USD — selinc.com/products/3530
SEL-3530-4: $2,850 USD — selinc.com/products/3530
SEL-3505: $799 USD — selinc.com/products/3505
SEL-3505-3: $1,095 USD — selinc.com/products/3505
SEL-3560S: $6,445 USD — selinc.com/products/3560
SEL-3560E: $7,345 USD — selinc.com/products/3560

Select models typically ship in 2 days

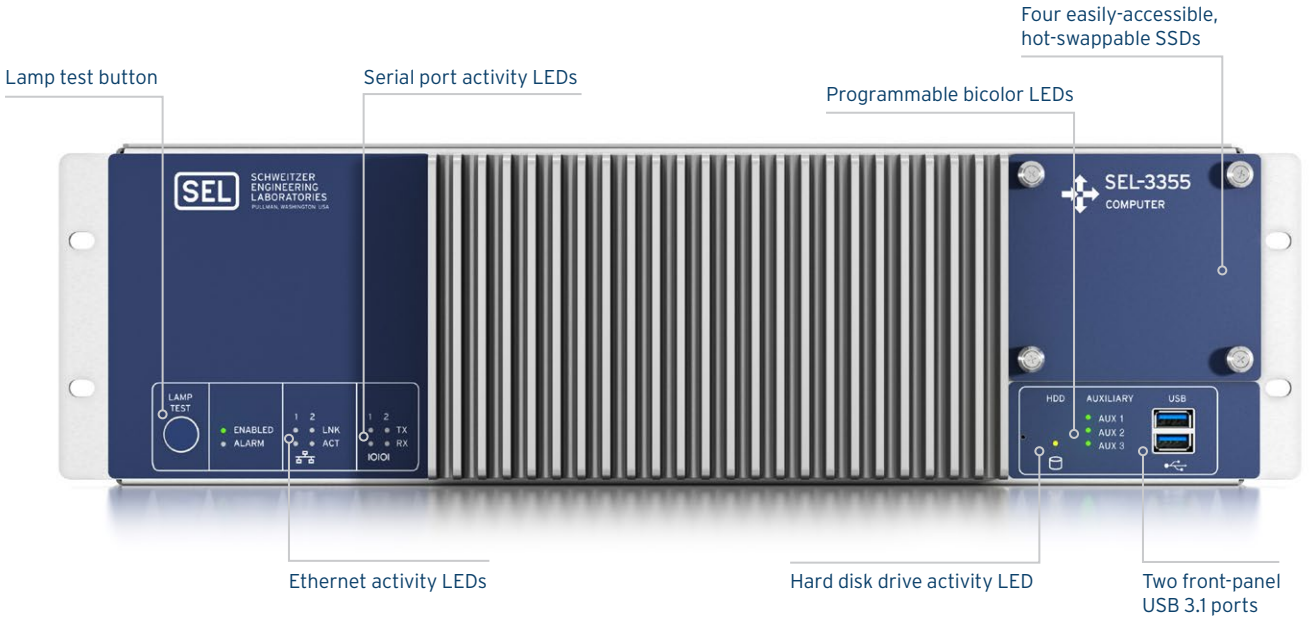
SEL RTACs offer everything from powerful data management solutions to precise, deterministic control for utility and industrial applications. Integrated cybersecurity features facilitate secure, mission-critical monitoring and control while ensuring regulatory compliance. With our ten-year, worldwide warranty and unmatched technical support, the RTAC is the right choice for high-speed, deterministic automation.

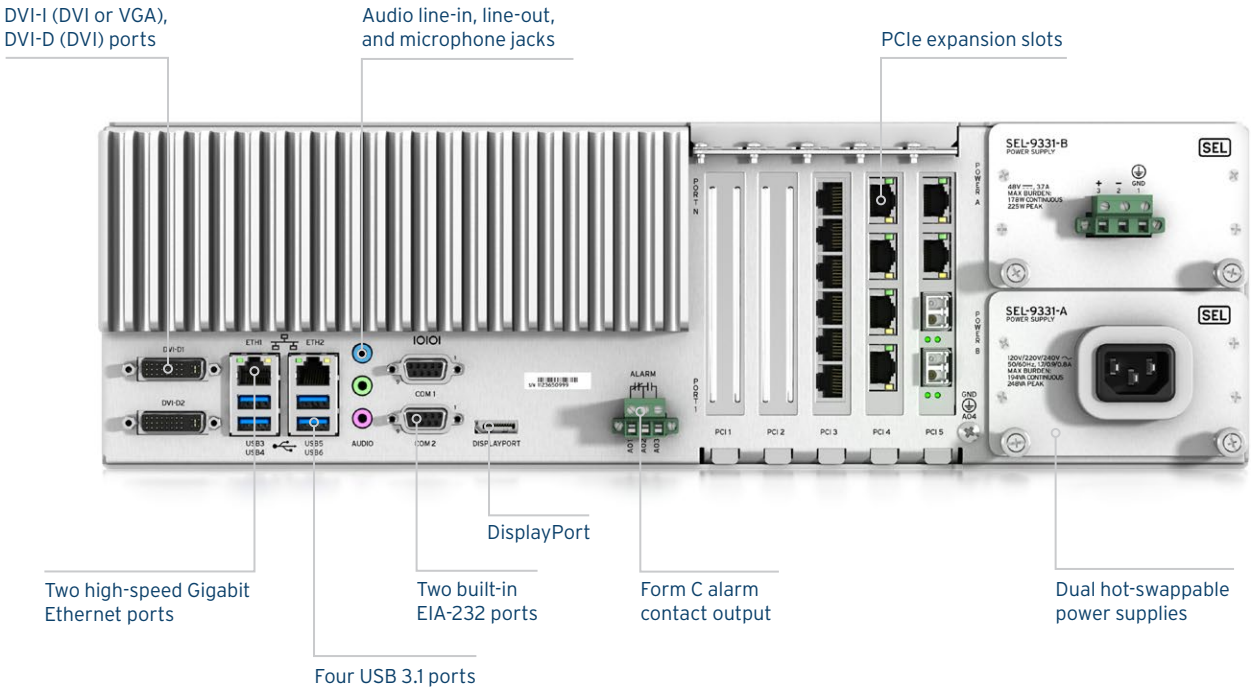
RTAC COMPARISON TABLE

FEATURES	SEL-3555	SEL-3530	SEL-3530-4	SEL-3505/ SEL-3505-3	SEL-3560	SEL-2240 Axion® With SEL-2241 Module
Processor	2.0 GHz Intel Xeon quad-core	533 MHz	533 MHz	333 MHz	2.0 GHz Intel Xeon quad-core	533 MHz
RAM	Up to 16 GB	1 GB	1 GB	512 MB	Up to 16 GB	1 GB
Storage	30 to 480 GB	2 GB	2 GB	2 GB	30 to 480 GB	2 GB
Operation Temperature	−40° to +75°C (−40° to +167°F)	−40° to +85°C (−40° to +185°F)			**SEL-3560S:** −40° to +75°C (−40° to +167°F) **SEL-3560E:** −40° to +60°C (−40° to +140°F)	−40° to +85°C (−40° to +185°F)
Graphical HMI and Video	Viewing and control via web browser; integrated video; 1 DisplayPort; 2 DVI-D ports	Viewing and control via web browser			Viewing and control via web browser; integrated video; 1 DisplayPort; 2 DVI-D ports	Viewing and control via web browser
Power Supply	**Redundant** 120/240 Vac, 125/250 Vdc; and/or 48 Vdc	**Single** 120/240 Vac, 125/250 Vdc; 48/125 Vdc, 120 Vac; or 24/48 Vdc		**Single** 12/24 Vdc or 24/48 Vdc	**SEL-3560S:** Optional redundant **SEL-3560E:** Single 120/240 Vac, 125/250 Vdc; and/or 48 Vdc	**Redundant** 120/240 Vac, 125/250 Vdc; and/or 24/48 Vdc
Ethernet Ports	2 standard (up to 8 additional with PCIe expansion)	3	2	2	**SEL-3560S:** 2 standard **SEL-3560E:** 2 standard (up to 8 additional with PCIe expansion)	2
Serial Ports	8 standard (up to 18 additional with PCIe expansion)	33 (3U)/ 17 (1U)	4	**SEL-3505:** 4 **SEL-3505-3:** 3	**SEL-3560S:** 2 standard **SEL-3560E:** 8 standard (up to 18 additional with PCIe expansion)	4
USB Ports	6 USB 3.1	USB-B	USB-B	USB-B	6 USB 3.1	USB-B
Size/Mounting	3U rack/ panel mount	3U or 1U rack/ panel mount	1U half-rack/ panel, surface, or DIN-rail mount	Surface or DIN-rail mount	Surface or DIN-rail mount	5U rack/panel or surface mount (10-slot, 4-slot, and dual 4-slot)
Digital and Analog Inputs and Outputs	1 DO	8 DO/24 DI (3U); 1 DO/1 DI (1U)	1 DO/1 DI	**SEL-3505:** 1 DO/1 DI **SEL-3505-3:** 3 DO/8 DI	1 DO	**Available Modules** DI, DO, Fast high-current DO, dc AI, ac AI, dc AO
Other Features	Conformal coating	Conformal coating	Conformal coating	**SEL-3505:** V.92 modem **Both:** Conformal coating, ambient light sensor, and accelerometer	Conformal coating	Conformal coating
RTAC HMI	Embedded RTAC HMI	Embedded RTAC HMI	Embedded RTAC HMI	N/A	Embedded RTAC HMI	Embedded RTAC HMI

SEL-3555 OVERVIEW

The SEL-3555 is a powerful solution for data management, either in the substation or at a central location. You can manage and archive system data, view real-time information, and control substation equipment. The built-in video port allows you to integrate an HMI for control, annunciation, and alarm management. The SEL-3555 provides the flexibility, reliability, and power to meet your most demanding substation automation projects. It supports EtherCAT® via the optional SEL-3390E4 Network Adapter Card for communicating with SEL-2240 Axion® nodes.





SEL-3530/3530-4 OVERVIEW

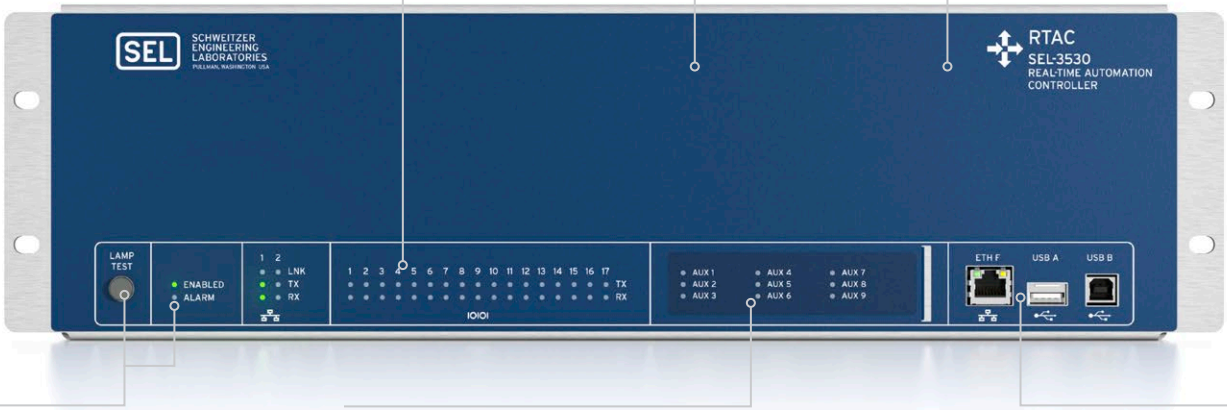
The SEL-3530/3530-4 RTACs are ideal for substation data concentration, for protocol conversion, and to provide a local or remote HMI for visualization and control. You can use the RTAC to interface with IEDs and communicate back to your SCADA or energy management system or for secure engineering access to protective relays from your desk.

SEL-3530

LEDs simplify diagnostics by indicating transmitted and received activity on each port.

Wide operating temperature range of −40° to +85°C (−40° to +185°F).

Rugged enclosure withstands electromagnetic interference (EMI), radio frequency interference (RFI), shock, and vibration.



Lamp test pushbutton and diagnostic LEDs.

Programmable bicolor LEDs with configurable labels provide custom annunciation.

Front Ethernet and USB ports for quick, convenient system setup and checkout.

Programmable I/O integrates local and remote control.

All terminals are clearly numbered and lettered for wiring and testing.

Independent Ethernet ports can be RJ45 or LC fiber.

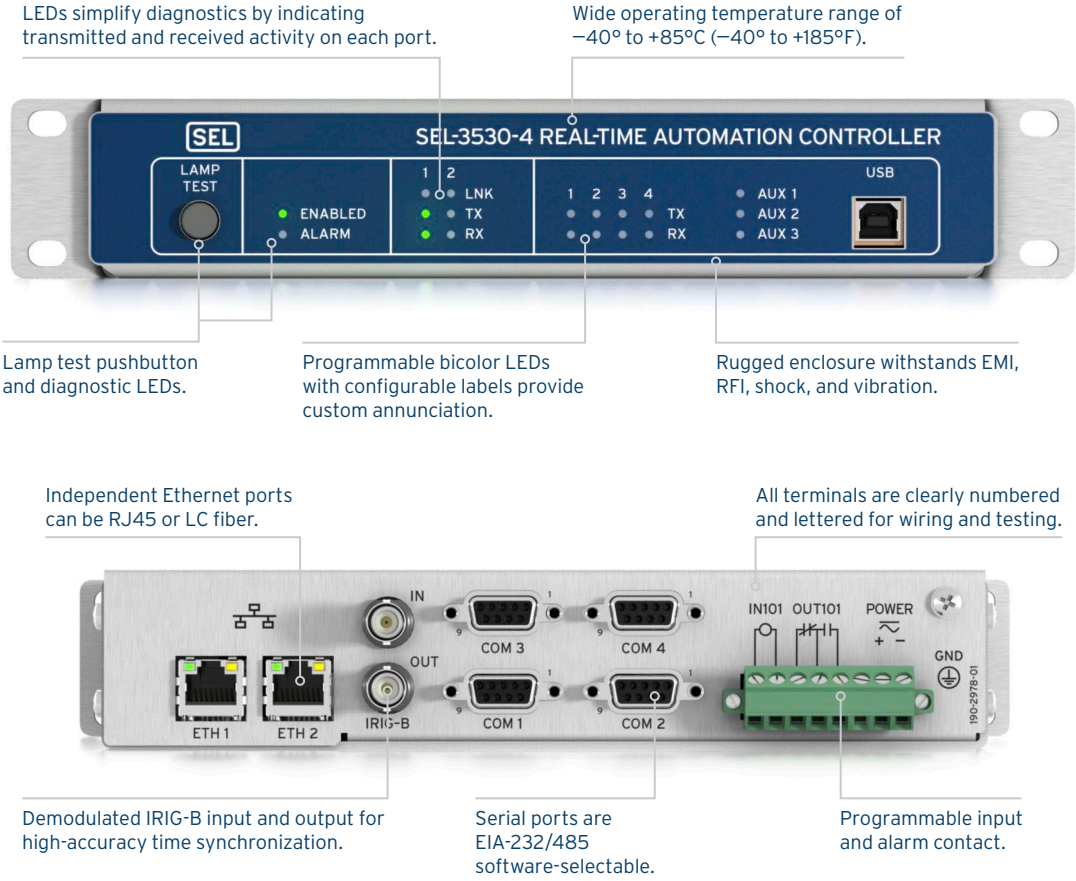
Serial ports are EIA-232/485 software-selectable.

Demodulated IRIG-B input and output for high-accuracy time synchronization.

Isolated EIA-232/485 port.

Programmable input and alarm contact.

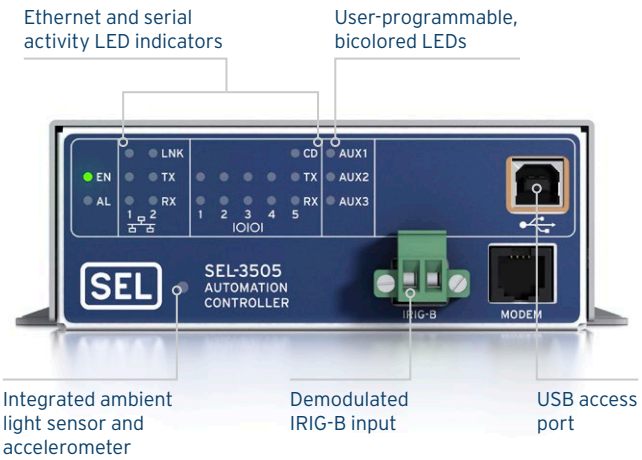
SEL-3530-4



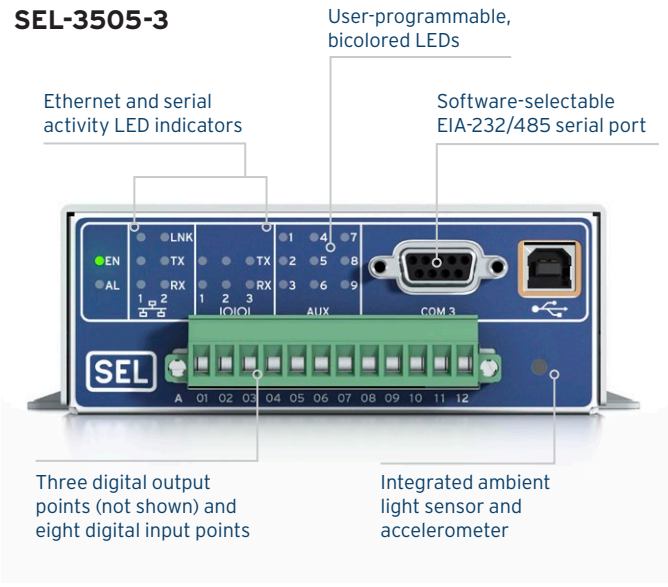
SEL-3505/3505-3 OVERVIEW

The SEL-3505/3505-3 RTACs are ideally suited for small enclosures, such as recloser controls, capacitor bank controls, or inverter cabinets that are exposed to harsh environmental conditions. You can use these compact, low-cost RTACs for protocol conversion, localized control and industrial applications, secure engineering access, or providing information to distribution automation systems. The SEL-3505 offers four serial ports, and the SEL-3505-3 offers three serial ports.

SEL-3505



SEL-3505-3

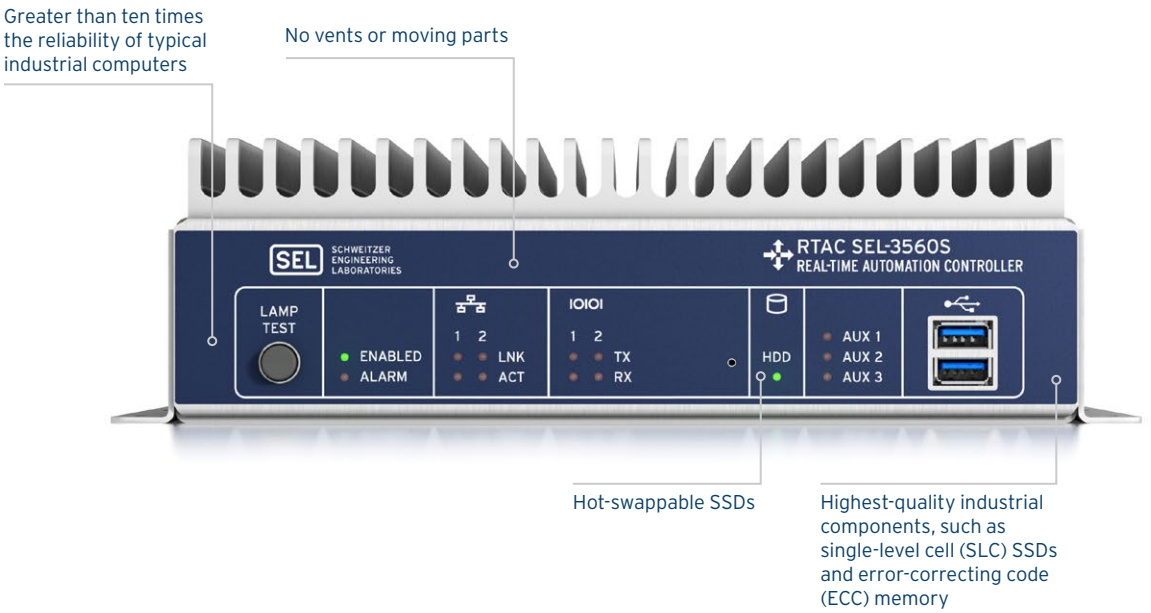


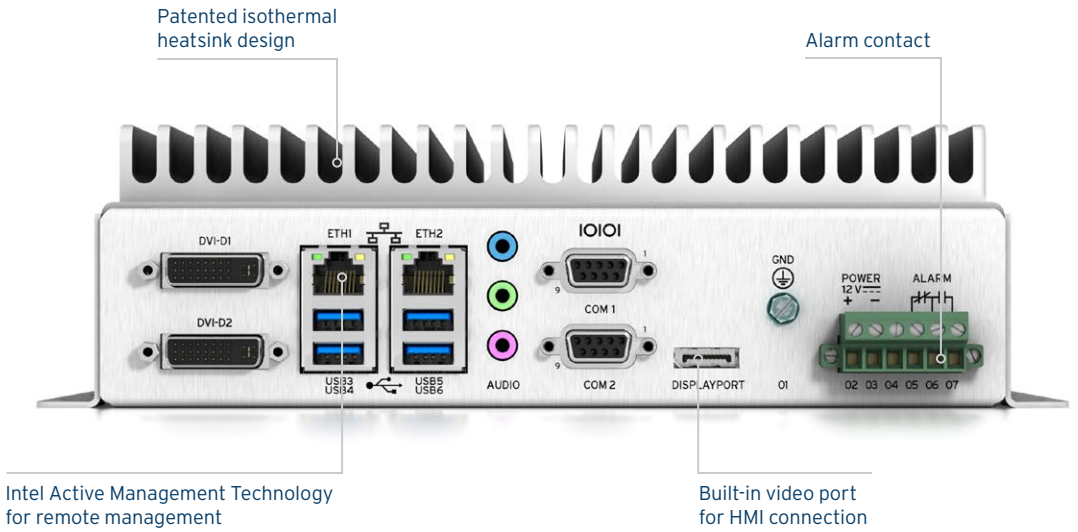
SEL-3560 OVERVIEW NEW

The SEL-3560 Compact Industrial RTAC is built to withstand harsh environments in utility substations, industrial control systems, and automation systems. You can manage and archive system data, view real-time information, and control substation equipment. The built-in video port lets you integrate an HMI for control, annunciation, and alarm management.

Designed, manufactured, and tested to the same standards as our protective relays, every SEL-3560 comes with a ten-year, worldwide SEL warranty. The SEL-3560 RTAC provides the flexibility, reliability, and power to meet your most demanding substation automation projects.

SEL-3560S

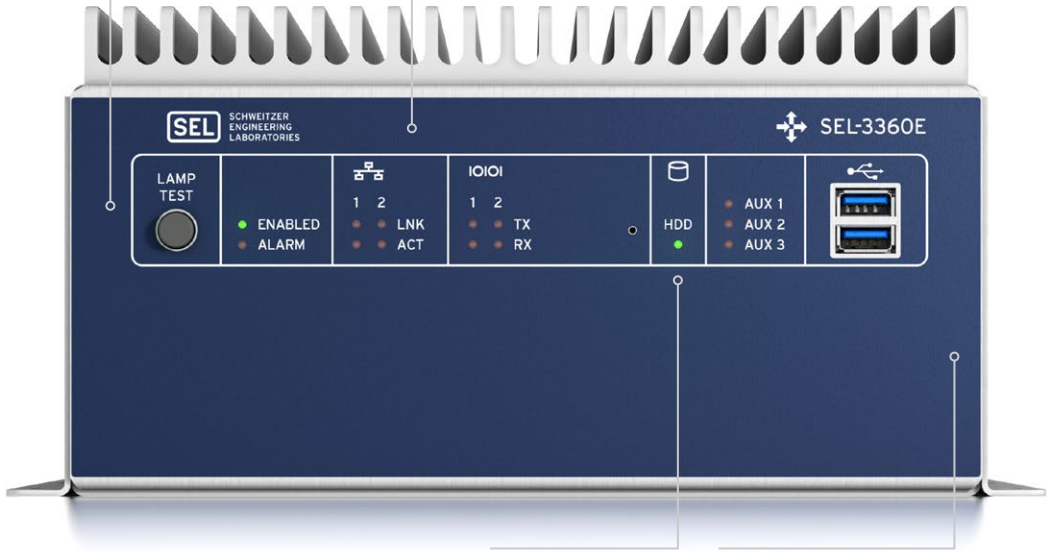




SEL-3560E

Greater than ten times the reliability of typical industrial computers

No vents or moving parts



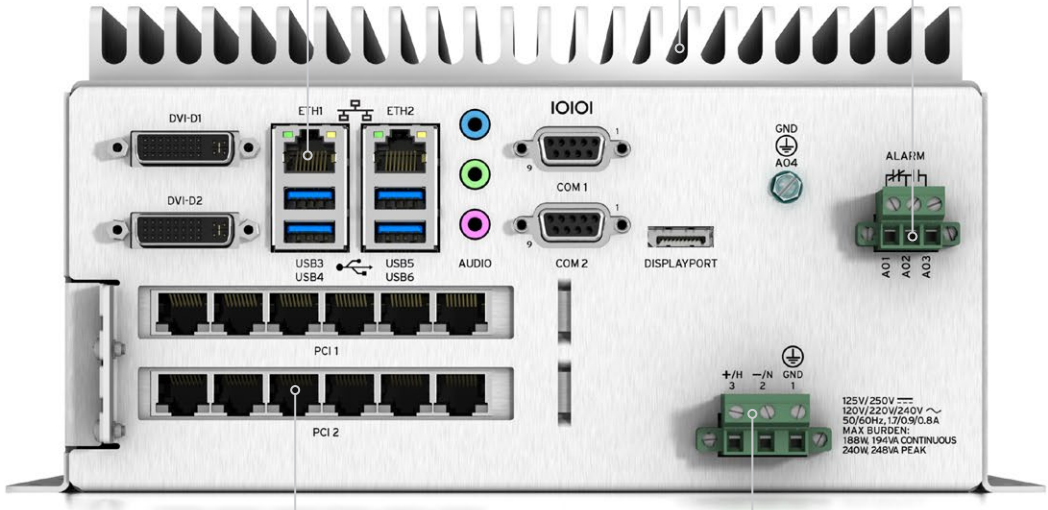
Hot-swappable SSDs

Highest-quality industrial components, such as SLC SSDs and ECC memory

Intel Active Management Technology for remote management

Patented isothermal heatsink design

Alarm contact

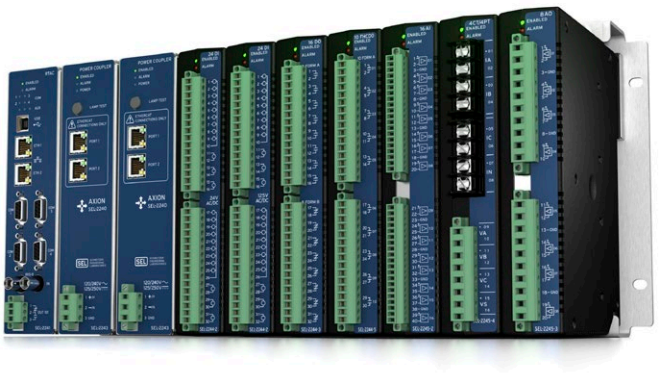


Two nonproprietary PCIe expansion slots

Built-in ac/dc power supply

SEL-2240

AXION®



Starting Price

SEL-2241 Real-Time Automation Controller (RTAC) Module: $2,400 USD

SEL-2242 Chassis/Backplane (10-Slot): $160 USD

SEL-2243 Power Coupler: $300 USD

SEL-2244 Digital I/O Module: $200 USD

SEL-2245-2 DC Analog Input Module: $975 USD

SEL-2245-22 DC Analog Input Extended-Range Module: $700 USD

SEL-2245-221 Low-Voltage (LEA) Monitoring Module: $700 USD NEW

SEL-2245-3 DC Analog Output Module: $975 USD

SEL-2245-4 AC Metering Module: $900 USD

SEL-2245-411 Standard-Current and Low-Voltage (LEA) Monitoring Module: $900 USD NEW

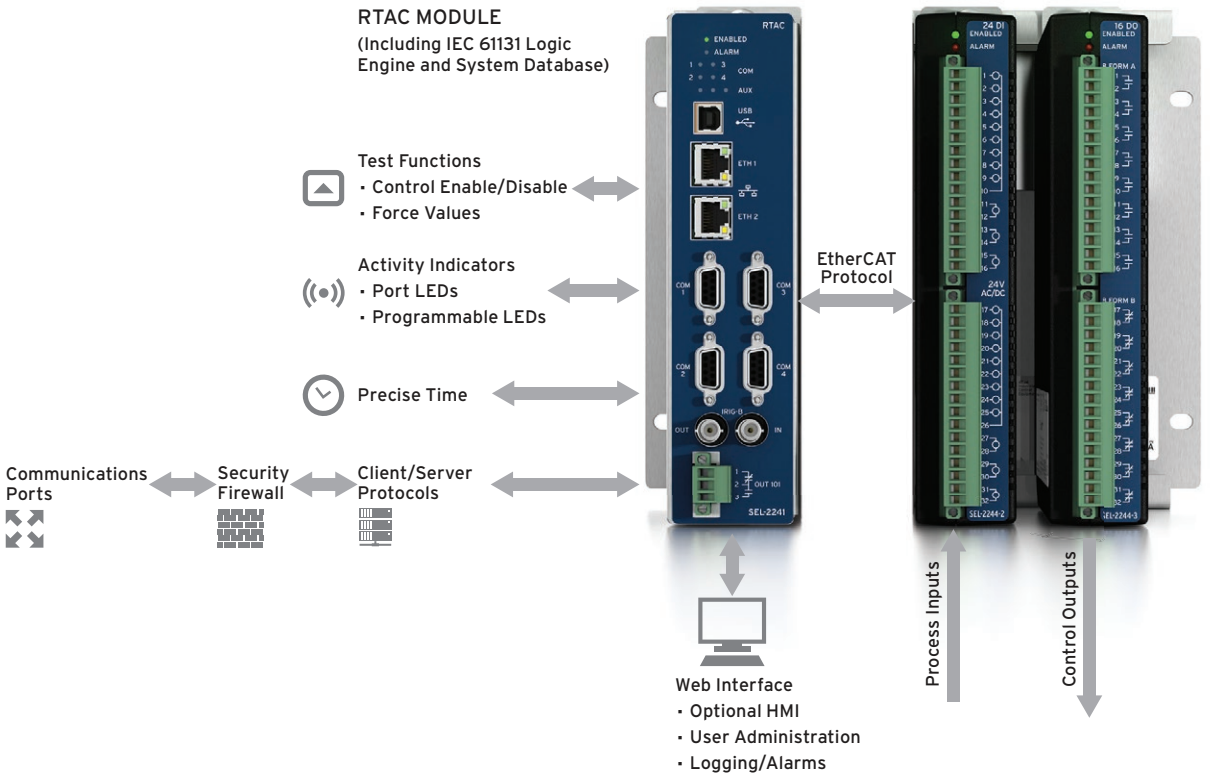
SEL-2245-42 AC Protection Module: $1,095 USD

selinc.com/products/2240

The SEL-2240 Axion is a fully integrated, modular I/O and control solution ideally suited for utility and industrial applications. It combines the communications, built-in security, and IEC 61131 logic engine of SEL Real-Time Automation Controllers (RTACs) with a durable suite of I/O modules that provide high-speed, deterministic control performance over an EtherCAT® network.

Whether your application calls for a remote terminal unit (RTU) or a rugged programmable logic controller (PLC), the Axion is a good match. All the modules are rated from −40° to +85°C (−40° to +185°F) and can include conformal coating. The system is designed to be flexible; you can select a combination of modules and nodes in almost any arrangement. The SEL-2244-3 Digital Output Module has substation-duty contacts (30 A make, 6 A carry) to provide reliable operation and flexible application.

The SEL-3530, SEL-3530-4, and SEL-3555 RTACs and the SEL-2241 RTAC Module can operate as the CPU for an Axion platform. They interface seamlessly with the I/O modules and provide easy integration with other serial and Ethernet devices via preinstalled communications protocols. The RTACs also support multiple SCADA/HMI channels. For high-speed communication, you can use EtherCAT fieldbus connections to I/O modules or optional IEC 61850 GOOSE messaging with station intelligent electronic devices (IEDs).

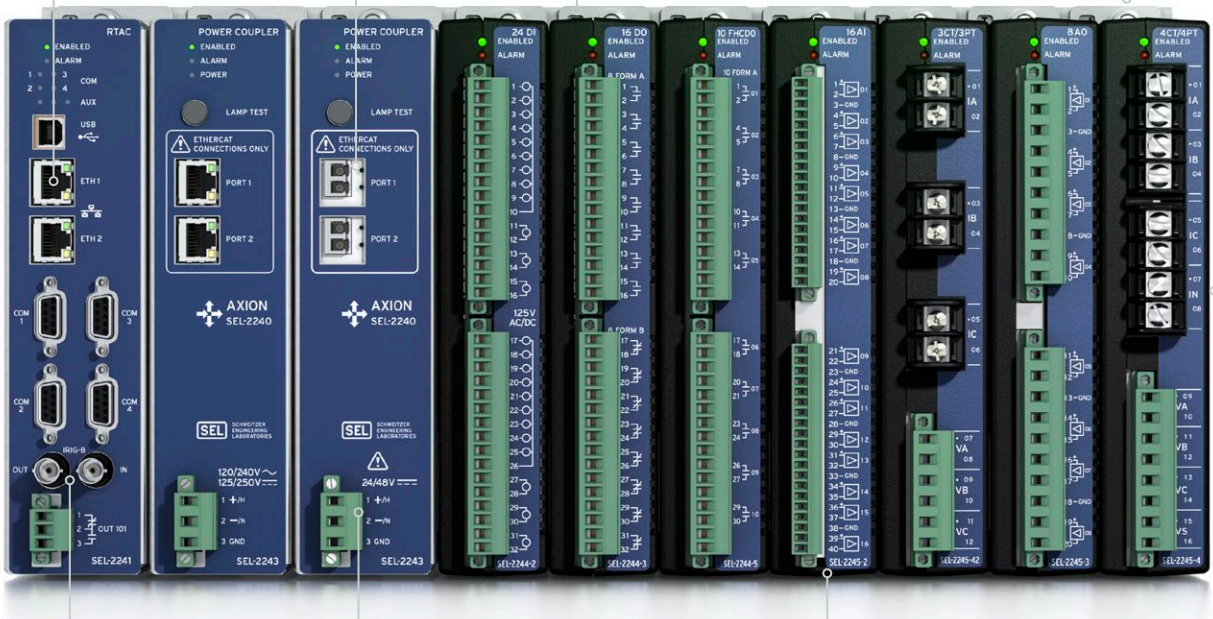


Two independent Ethernet ports are available in either copper or LC fiber and can operate on separate subnets.

Fiber-optic ports are available in multimode or single-mode.

Slot identification is visible even when in use.

Module alignment guides for easy installation.

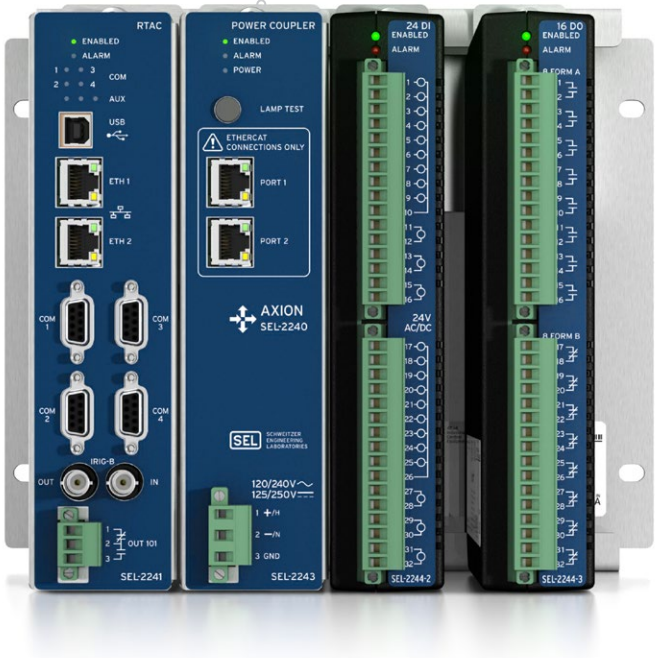


SEL-2241 RTAC integrates I/O, substation IEDs, SCADA communications, and security applications.

SEL-2243 Power Coupler is the Axion system power supply.

Four-slot, dual four-slot, or ten-slot chassis available.

Surface- or rack-mount chassis.



AXION MODULE OPTIONS

SEL-2241 RTAC Module
SEL-2242 Chassis/Backplane
SEL-2243 Power Coupler
SEL-2244-2 Digital Input Module
SEL-2244-3 Digital Output Module
SEL-2244-5 Fast High-Current Digital Output Module
SEL-2245-2 DC Analog Input Module
SEL-2245-22 DC Analog Input Extended-Range Module
SEL-2245-221 Low-Voltage (LEA) Monitoring Module
SEL-2245-3 DC Analog Output Module
SEL-2245-4 AC Metering Module
SEL-2245-411 Standard-Current and Low-Voltage (LEA) Monitoring Module
SEL-2245-42 AC Protection Module

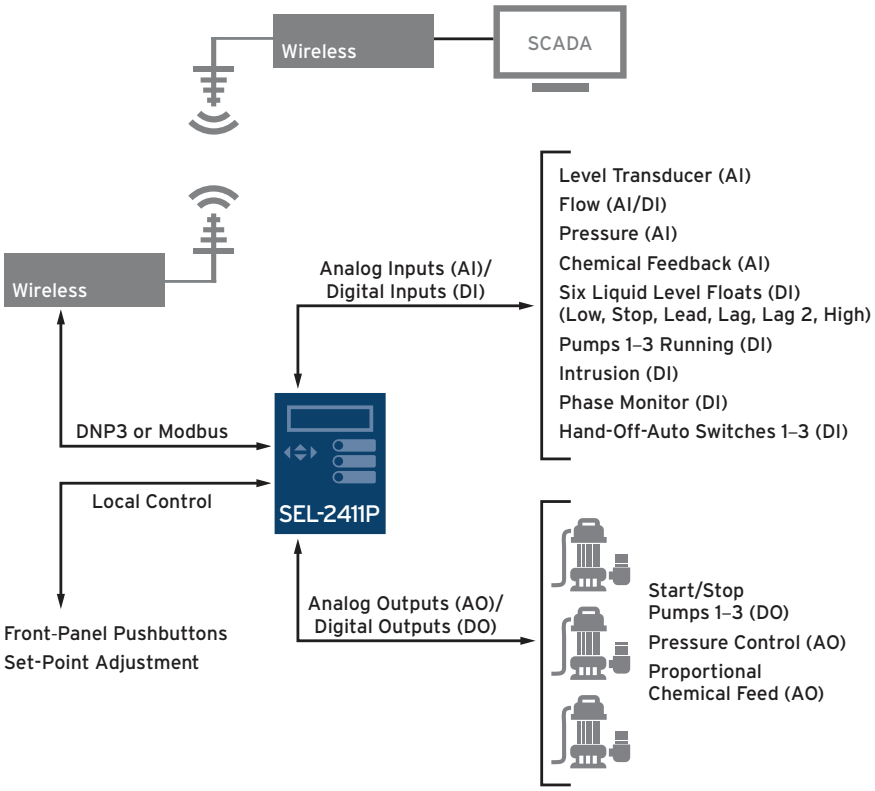
SEL-2411P

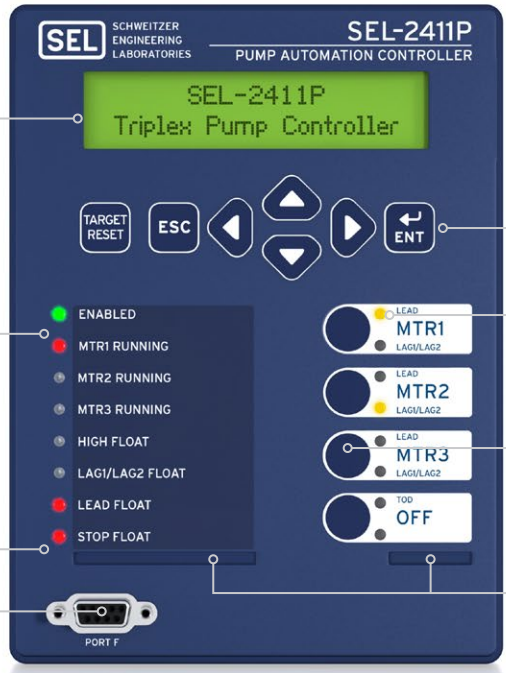
PUMP AUTOMATION CONTROLLER

Starting Price
$1,800 USD

selinc.com/products/2411P

The SEL-2411P is a standalone, preconfigured, SCADA-ready system for the control and monitoring of multiple water and wastewater pumps that perform liquid level control. It is designed for pump-up and pump-down applications, such as lift stations (pump down) and wells or reservoirs (pump up). The SEL-2411P is UL-listed and withstands harsh water and wastewater environments. It is available with conformal coating to protect against corrosive gases, fumes, or liquids. Flexible I/O options, communications protocols, setting templates, and connectivity to wired and wireless technologies let you easily integrate the SEL-2411P into new or retrofit applications.





Large 2 × 16 character LCD.

Simple front-panel navigation enables easy access to device configuration, detailed I/O status, alarms, and measured values.

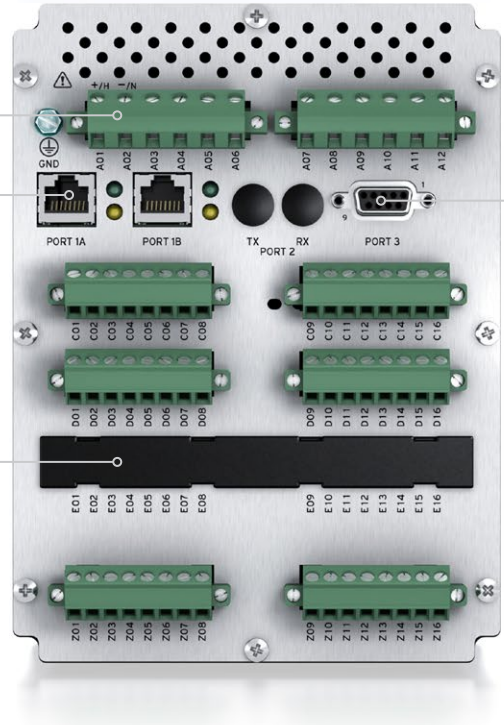
LEDs to indicate control state.

7 programmable LEDs to indicate I/O activity and device status.

Local controls with easy-to-use push-buttons enable and disable motors.

Slide-in configurable labels.

Built-in EIA-232 serial port.



Power supply options include 24/48 Vdc, 125/250 Vdc, 120/240 Vac, and 50/60 Hz.

One rear-panel EIA-232 serial port.

Dual copper Ethernet ports include Modbus TCP, DNP3, and SEL protocols.

Position for one optional card to add analog I/O, additional digital I/O, or ac voltage and current inputs.

FEATURE	DESCRIPTION
I/O Plug-In Cards	**Pre-installed cards:** one 4 digital input (DI)/4 digital output (DO) card, one 8 DI card. **Configurable I/O card options:** 8 DI, 14 DI, 4 DI/4 DO, 8 analog input (AI), 4 AI/4 analog output (AO), or 3 ac current input (ACI)/3 ac voltage input (AVI).
Rapid Configuration	90 percent of installations can be configured by entering six settings parameters on the front panel.
Protocols	Modbus RTU and TCP, DNP3, DNP3 LAN/WAN, Mirrored Bits®, SEL ASCII, and binary communications.
Communications	Two 10/100 Ethernet ports and two EIA-232 ports (front and back).
Certifications	UL; CSA; Class 1, Div. 2.

SEL-2440

DISCRETE PROGRAMMABLE AUTOMATION CONTROLLER (DPAC)

Starting Price
$960 USD

selinc.com/products/2440

Select models typically ship in 2 days

The SEL-2440 is a 48-point automation controller ideally suited for utility and industrial applications that require rugged and reliable I/O. The SEL-2440 is a fast and powerful communications device that is easy to maintain and support, and it meets stringent protective relay standards. Mounting options include rack, panel, surface, and DIN-rail mounts. An optional I/O board provides ten fast high-current digital outputs with a pick-up time of less than 85 µs, depending on the voltage level.

SEL-2411

PROGRAMMABLE AUTOMATION CONTROLLER

Starting Price
$950 USD

selinc.com/products/2411

The SEL-2411 automates continuous and discrete processes using powerful logic, math, timer, counter, and edge-trigger functions. Designed to withstand harsh physical and electrical environments, the SEL-2411 is built and tested to meet mission-critical IEEE and IEC protective relay standards. With flexible communications and I/O options, the SEL-2411 can easily integrate with SCADA and meets your sequential events reporting, station integration, remote monitoring, ac metering, and plant control system needs. A large touchscreen display option provides an advanced local user interface that is simple to use.

SEL-2032

COMMUNICATIONS PROCESSOR

Starting Price
$2,840 USD

selinc.com/products/2032

Suitable for use in utility substations or industrial control and automation systems, the SEL-2032 is a simple and reliable solution for replacing remote terminal units and other devices. With no extra wiring, one SEL-2032 provides a Sequential Events Recorder (SER), event report retrieval, and clear communication between other intelligent electronic devices (IEDs). The integrated database collects, stores, and forwards meter and load profile data, event reports, and targets.

SEL-3573

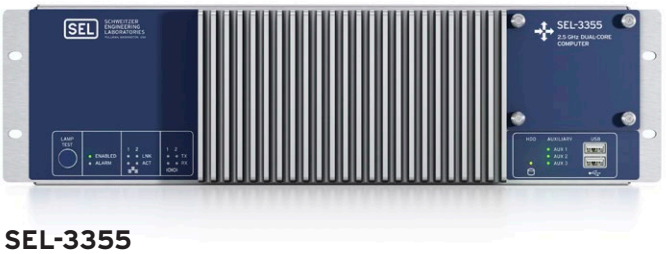
STATION PHASOR DATA CONCENTRATOR (PDC)

Starting Price
$7,500 USD

selinc.com/products/3573

The SEL-3573 connects to any IEEE C37.118 phasor measurement unit (PMU) or client, such as the SEL-3555 Real-Time Automation Controller (RTAC) or SEL-5078-2 SYNCHROWAVE® Central Software. It is easy to use and configure with the included PDC Assistant Software. Additionally, archiving is built into the SEL-3573, allowing you to save all PMU data to the internal SSD in a secure database. This ensures that no PMU data are lost if communication with the substation is disrupted. You can use the PDC as part of your NERC PRC-002 disturbance monitoring system. Up to ten configurable outputs can send data to different locations or organizations, such as an independent system operator (ISO) or a regional coordinating council.

COMPUTING OVERVIEW

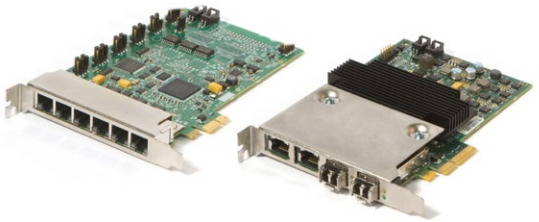


SEL-3355

The SEL-3355 is a server-class computer built to withstand harsh environments in utility substations and industrial control and automation systems.

SEL-3360S/3360E

The SEL-3360S and SEL-3360E match the power and ruggedness of the SEL-3355 and are ideal for limited-space applications.



SEL-3390

SEL PCIe expansion cards let you add ports and connectivity to rugged computers.

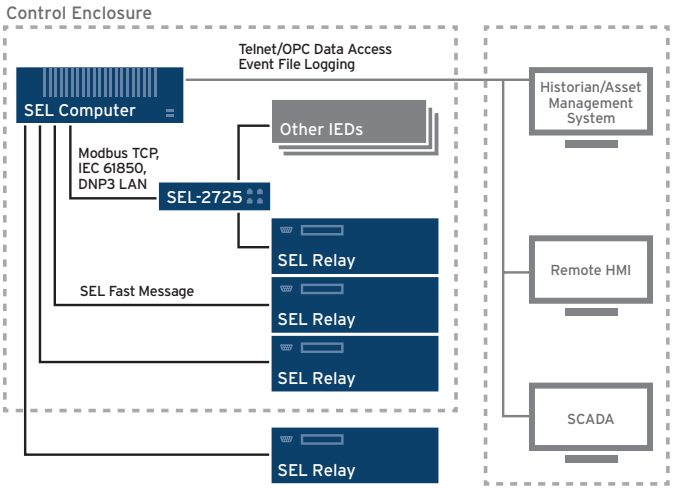
SEL-9331

The SEL-9331 powers equipment in industrial environments where many power supplies cannot maintain operation.

	SEL-3355	SEL-3360E	SEL-3360S
APPLICATIONS			
Computing in Harsh Environments	•	•	•
Running Multiple Applications Simultaneously	•	•	•
Installing Third-Party Software	•	•	•
Embedding Into Automation and Monitoring Systems	•	•	•
HMI	•	•	•
Security Gateway to Help Satisfy NERC CIP Requirements	•	•	•
Network Monitoring and Intrusion Detection	•	•	•
Virtualization Server	•	•	•
Engineering Access Point	•	•	•
IRIG-B Time Distribution and Network Time Protocol (NTP) Conversion	•	•	•
Video Surveillance Control and Archiving/Physical Security Monitoring and Notification	•	•	•
SEL Secure Kiosk	•	•	•
SUPPORTED OPERATING SYSTEMS			
Microsoft Windows 8/8.1, 10 IoT*; Windows Server 2012 R2 Standard; Windows Server 2016 Standard*; Windows Server 2019 Standard*; CentOS Linux 6 and 7; Ubuntu 16.04 LTS and Ubuntu 18.04 LTS; Red Hat Enterprise Linux 6 and 7; VMware ESXi 5.x—6.0; SEL Kiosk*; None (User-Loaded Operating System)	+	+	+
PRE-INSTALLED SOFTWARE			
SEL Software	+	+	+
McAfee Whitelist Antivirus	+	+	+
SISCO AX-S4 IEC 61850 GOOSE OPC Server	+	+	+
HARDWARE			
Intel Xeon E3-1505L Quad-Core 2.0 GHz 64-Bit CPU	•	•	•
Intel Xeon E3-1515M Quad-Core 2.8 GHz 64-Bit CPU	+		+
4 GB DDR4 ECC PC4-17000 (2,133 MHz) System Memory	•	•	•
Up to 32 GB DDR4 ECC PC4-17000 System Memory	+	+	+
Triple Independent Video Displays (2 DVI-D and 1 DisplayPort)	•	•	•
HD Audio Ports, Line In, Line Out, Microphone	•	•	•
Six USB Ports, USB 3.1-Compliant, 2.0 A Max. Current Limit Each (Up to 4 A Combined Front and 4 A Combined Rear)	•	•	•
Two 10/100/1000 Mbps Independent Copper Ethernet Ports	•	•	•
Two EIA-232 Serial Ports, DB-9 Connectors, 300 to 115,000 bps	•	•	•
IRIG-B Input on COM1	•	•	•
IRIG-B When Used With the SEL-3390E Network Card	+	+	
19" Rack-Mount Chassis	•		
Wall-Mount Chassis		•	•
Conductive Panel Mount		•	•
PCI/PCIe Expansion Slots	5	2	
Additional EIA-232/422/485 Serial Ports, RJ45 Connectors, 300 to 921,000 bps, IRIG-B Inputs/Outputs, +5 Vdc Power Via PCIe Cards	24	12	
Additional 10/100/1000 Mbps Ethernet Ports, Copper RJ45, or Fiber-Optic SFP LC Connectors Via PCIe Cards	8	8	
Solid-State Drives (2.5" SLC, iMLC, MLC SATA II, 30 GB—2 TB Drives)	4	2	2
Internal 120/230 Vac, 125/250 Vdc, or 48 Vdc Power Supply	•	•	
Secondary Internal 120/230 Vac, 125/250 Vdc, or 48 Vdc Power Supply	+		
Hot-Swappable Power Supplies	•		
External Power Supply			+
Alarm Contact, Alarm LED, Watchdog Processor	•	•	•
Three Programmable Auxiliary Bicolor LEDs	•	•	•
Intel Active Management Technology (AMT) v8.1	•	•	•
Trusted Platform Module (TPM) v1.2	•	•	•

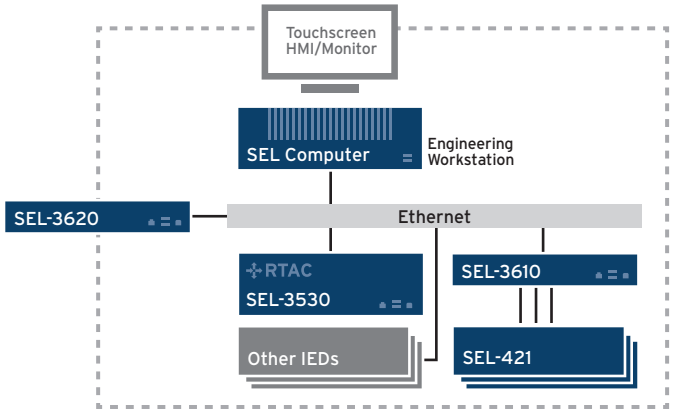
• Standard feature + Model option *Factory-orderable operating system

COMPUTING APPLICATIONS



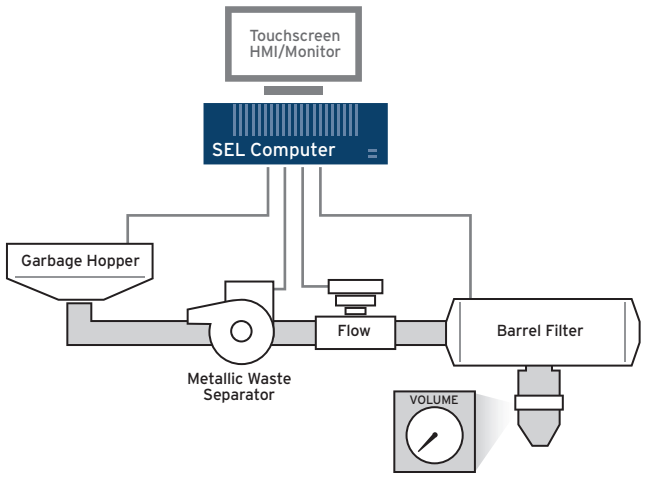
INFORMATION PROCESSOR: DATA CONCENTRATOR/PROTOCOL CONVERTER

Seamlessly and flexibly concentrate data and convert protocols with any SEL computer and a wide range of data concentration and protocol conversion software.



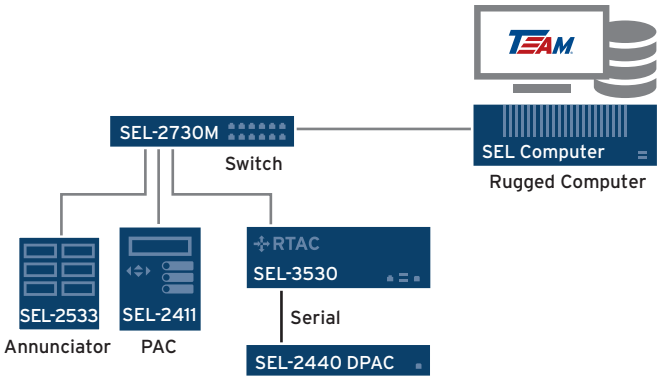
ENGINEERING WORKSTATION

Choose an SEL computer as your engineering workstation platform, and get a reliable and robust system suitable for the harshest environments. You can view and change IED settings, view report and event data, and easily access diagram drawings and documents onsite. Securely and remotely access the engineering workstation using Microsoft Windows Remote Desktop, Secure Shell (SSH), or out-of-band management with Intel Active Management Technology (AMT) Keyboard-Video-Mouse (KVM) over IP.



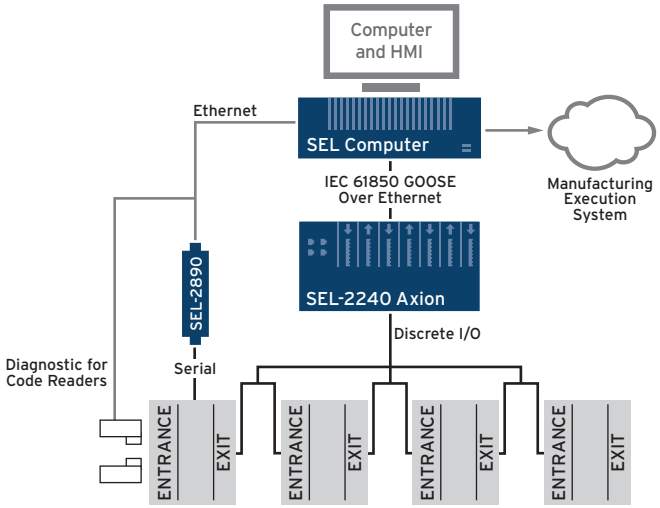
INDUSTRIAL PROCESS CONTROL PLATFORM

SEL computers are perfect for any industrial control system requiring the power of a rugged, reliable, highly available computer. Implement your control system with your choice of SCADA software. With ample communications ports (serial or Ethernet), the SEL-3355 Computer and SEL-3360E Compact Industrial Computer are also ideal for distributed control systems.



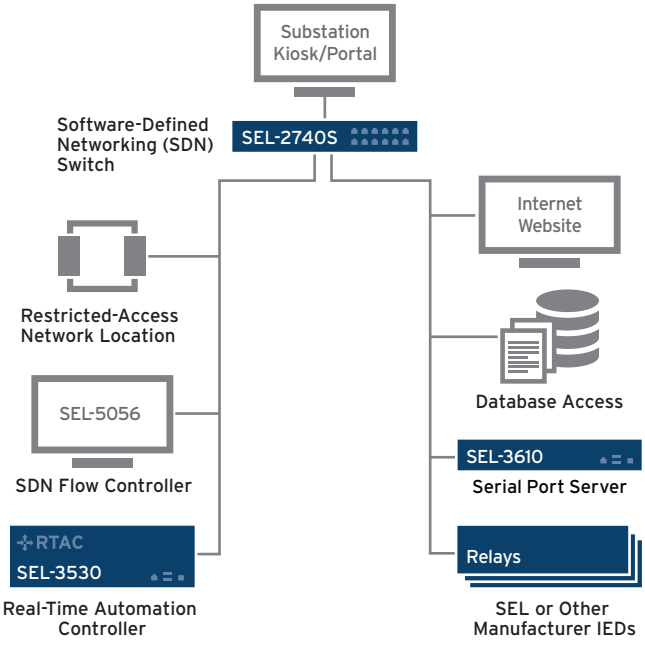
DATA ARCHIVER

Leverage the RAID capabilities of the SEL-3355 or an SEL-3360 to store and access your critical data. Depending on your needs, you can optimize the SEL-3355 SSD subsystem for speed, extra data protection, or both. SEL computers can run your favorite historian software for large data analysis projects, or they can serve as the processing and archiving engine for your disturbance recording and monitoring system.



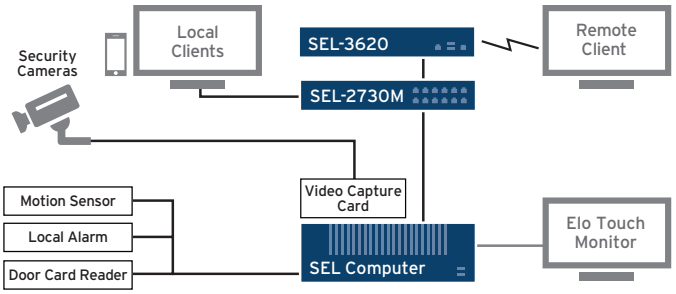
DEFECT TESTING SYSTEM IN FACTORY AUTOMATION

Use legacy and new PCI standard data acquisition cards to connect and automate diverse devices and sensors in factories where normal computers cannot withstand harsh environmental temperatures or caustic conditions.



SEL KIOSK

The SEL Kiosk is a secure and lightweight embedded operating system that runs on SEL computers to give predefined access to a virtual environment. It allows administrators to define which systems are accessible by generating a controlled whitelist of devices that end users may access, monitor, or configure.

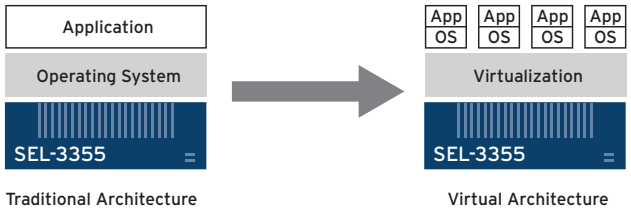


DIGITAL VIDEO RECORDER

Store video security footage and local environmental monitoring data in harsh locations with a conformally coated SEL-3355 or SEL-3360. You can attach card readers, IP cameras, temperature sensors, motion sensors, door contacts, and other IP, serial, and PCI peripherals.

SYNCHROPHASOR PHASOR DATA CONCENTRATOR, ARCHIVER, VIEWER, AND ANALYZER

Concentrate and archive synchronized phasor measurements from a single station or a wide area with SEL-5073 SYNCHROWAVE® Phasor Data Concentrator (PDC) Software. SEL-5078-2 SYNCHROWAVE Central Software lets you view and analyze synchrophasor data. You can load both software packages onto a single SEL computer to provide a powerful solid-state synchrophasor system for a substation or central office.



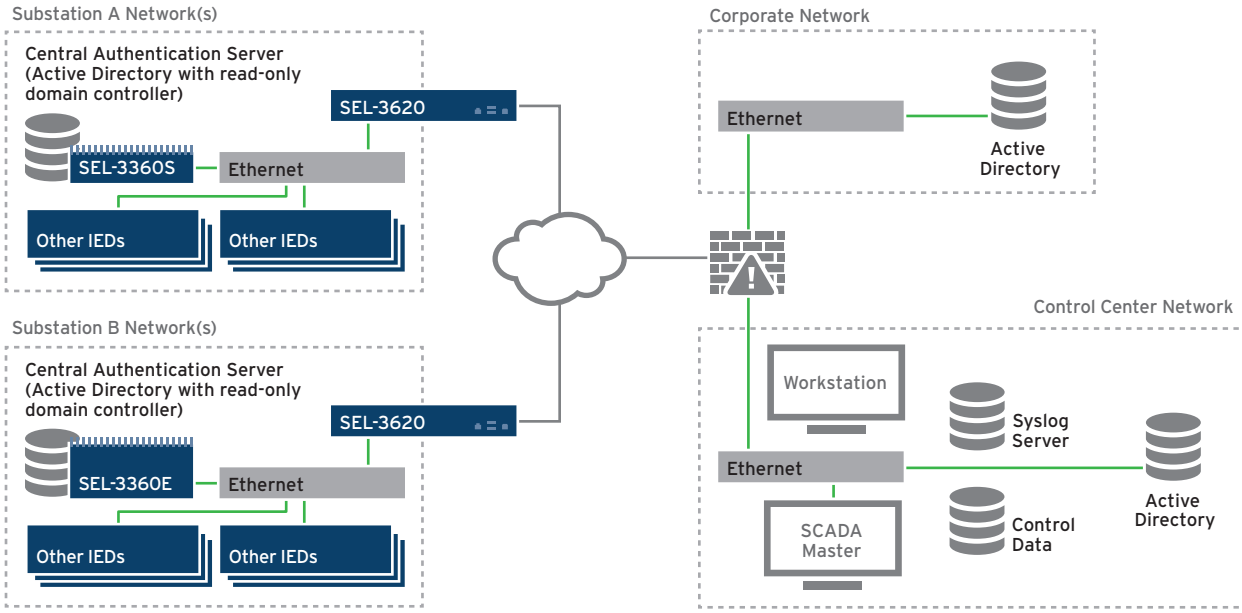
VIRTUALIZATION SERVER

Create your own virtualization appliance by leveraging Virtualization Technology (VT-x) to allow one hardware platform to function as multiple virtual platforms. Isolating your computing activity onto separate virtual machines helps improve manageability, reduce downtime, and maintain productivity.

HMI VISUALIZATION, MONITORING, AND CONTROL

Create custom screens for control processes, viewing, and monitoring with the SEL RTAC HMI or user-installed HMI software. A rugged SEL computer can serve as a reliable and robust platform for an HMI visualization, monitoring, and control system in harsh environments.

Move your computing-intensive distributed control system applications as close to your equipment as you need. A small footprint and broad operating temperature range make it possible to install an SEL-3360 in locations where many computers would either not fit or not survive. This flexible installation means you can ensure local equipment control is maintained even when communications with the master control center are lost. With the SEL-3360E, you can install additional I/O cards to meet a variety of control needs. For even greater flexibility, the built-in Intel AMT functionality lets you remotely service the units.



CENTRALIZED AUTHENTICATION SERVER

Extend enterprise central authentication to your remote branch office or substation, and use enterprise credentials to allow role-based access control and meet industry standards, such as NERC CIP, NIST SP800 53/82, IEEE 1686, and IEC 62351.

SEL-3355
COMPUTER

Starting Price
$3,545 USD

selinc.com/products/3355

The SEL-3355 is built to withstand harsh environments in utility substations and industrial control and automation systems. SEL computers have over ten times the mean time between failures (MTBF) of typical industrial computers because they eliminate all moving parts, including rotating hard drives and fans, and use error-correcting code (ECC) memory technology.

PERFORMANCE AND DURABILITY

High-Performance Computing Power—The SEL-3355 has third-generation Intel Xeon E3 quad-core processors, enabling up to 2.8 GHz of processing power. High-speed single-level cell (SLC) SSDs in four slots, with up to 256 GB per slot, and ample system memory (4 to 32 GB of DDR4 ECC memory) provide computing resources for your most demanding applications. New multilevel cell (MLC) and industrial-grade MLC (iMLC) drive options extend the storage capacity to 480 GB per slot.

Protective Relay Standards—The SEL-3355 is suitable for harsh environments, including those with temperatures ranging from −40° to +75°C (−40° to +167°F), up to 15 kV of electrostatic discharge, fast transients, radiated emissions, overcurrents, and pulsed magnetic field disturbances. The SEL-3355 conforms to IEC 61850-3, IEEE C37.90, IEEE 1613, and IEC 60255 standards.

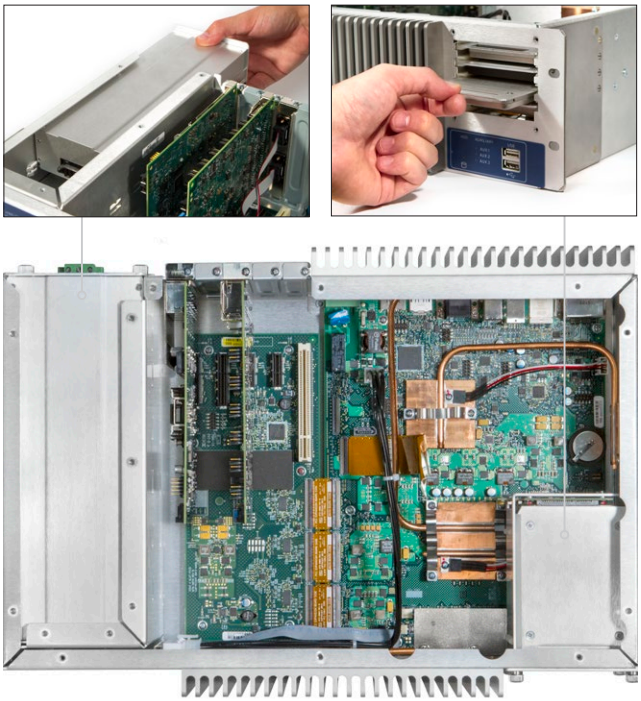
RELIABLE, AVAILABLE, AND SERVICEABLE

The SEL-3355 is a server-class computer with respect to RAS—reliability, availability, and serviceability. Industrial computer systems need to always be available and easy to service.

Reliability—SEL designs, manufactures, and tests every computer in-house to the same standards as our protective relays. Our computing systems have an MTBF of over 100 years, ten times higher than that of the typical industrial computer. In addition, the SEL-3355 is backed by a ten-year, no-questions-asked warranty.

Availability—Features like dual power supplies and Intel Active Management Technology (AMT) for out-of-band remote management keep your system operational.

Serviceability—AMT allows you to view diagnostic logs for evaluation and service even when the unit is turned off. You can reboot the computer into another OS for diagnostics or to batch software and then can bring the system back online, all remotely. AMT's remote Keyboard-Video-Mouse (KVM)-over-IP feature lets you get hands-on help and guidance from an expert at the central office to speed up serviceability. The SEL-3355 also features the unique SEL system monitor (SysMon) with a watchdog timer. SysMon logs computer events specific to the installed system to aid in faster recovery.



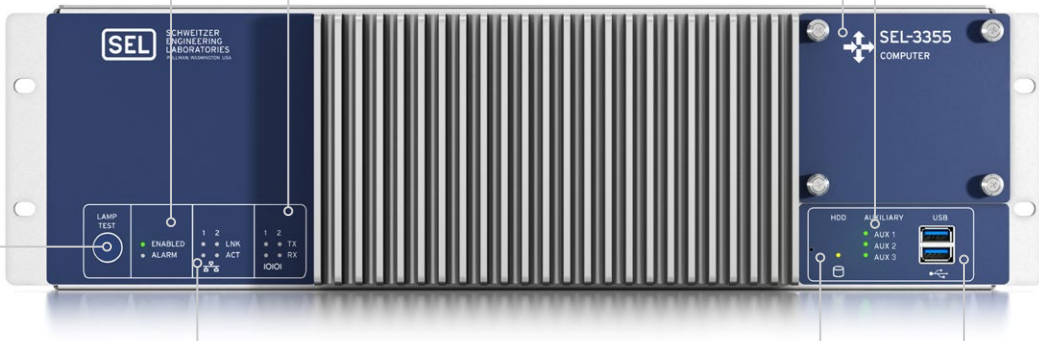
Observe the "ENABLED" LED for operational status. Green indicates normal operation, and red indicates that the system is halted or booting or that an error condition has occurred.

The "ALARM" LED indicates that a nonoptimal system condition exists. The alarm LED illuminates red when the alarm contact operates.

Install up to four hot-swappable SSDs behind the easily accessible front panel. You can tailor the drive technology to your application with SLC, MLC, and iMLC SSD options. A RAID configuration provides even higher data availability.

Transmit and Receive LEDs indicate activity on serial ports.

Program three bicolor LEDs for your custom application.



Test all LEDs with the lamp test button.

View link and activity LEDs for link status and network activity on each Ethernet port.

See hard disk drive activity at a glance with the LED indicator.

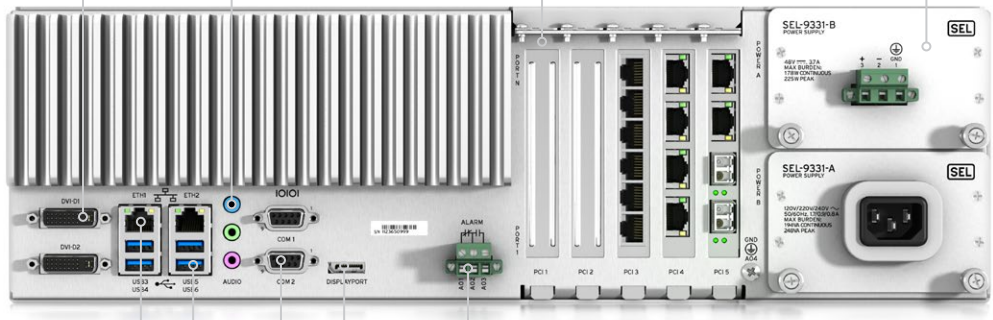
Attach one or two USB 3.1 devices, enabling custom, application-specific peripherals.

Line-in, line-out, and microphone jacks for high-definition analog audio applications.

Use SEL rugged or third-party PCI expansion cards for additional networking, serial, time, video, or any other application-enabling solutions.

Choose dual power supplies, and attach power from independent sources for even higher availability. Supplies are hot-swappable for maximum online serviceability.

Connect three simultaneous displays using two DVI-D ports and one DisplayPort interface.



Network with two high-speed Gigabit Ethernet ports. Ports can be teamed for redundancy or used individually.

Wire a Form C alarm contact output either normally closed or normally open. The alarm LED on the front provides indication of the alarm contact state.

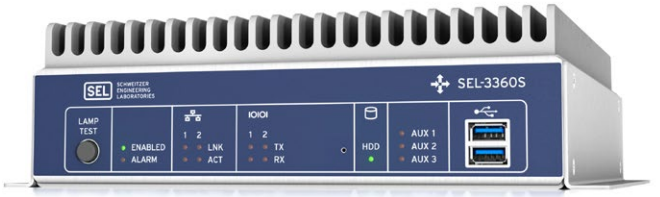
Attach up to four USB 3.1 devices, enabling custom, application-specific peripherals.

DisplayPort technology offers higher performance features than any other digital interface.

Configure two built-in EIA-232 ports in the BIOS for +5 V on Pin 1.

SEL-3360

COMPACT INDUSTRIAL COMPUTER



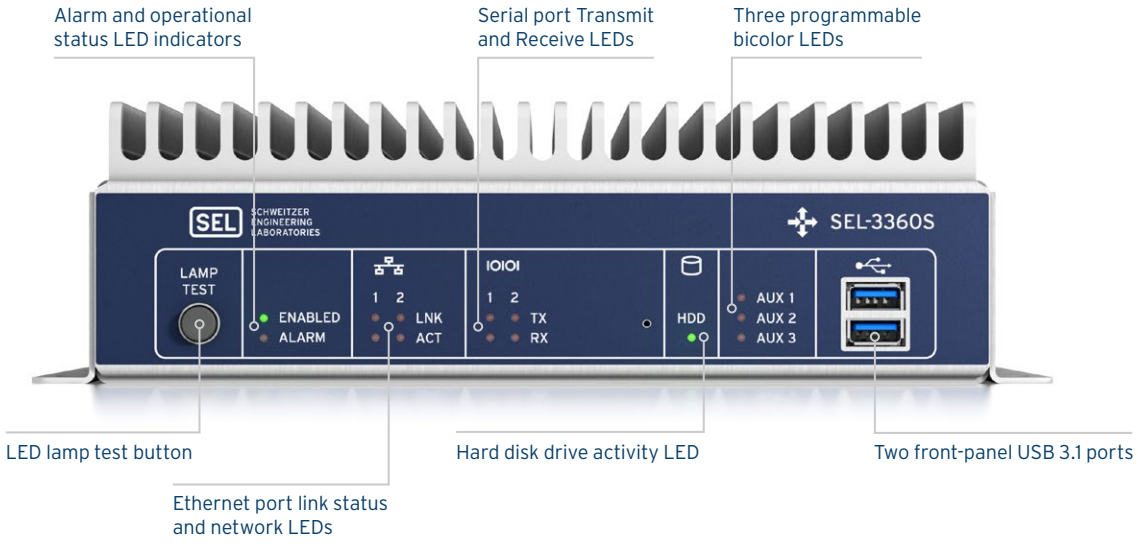
Starting Price

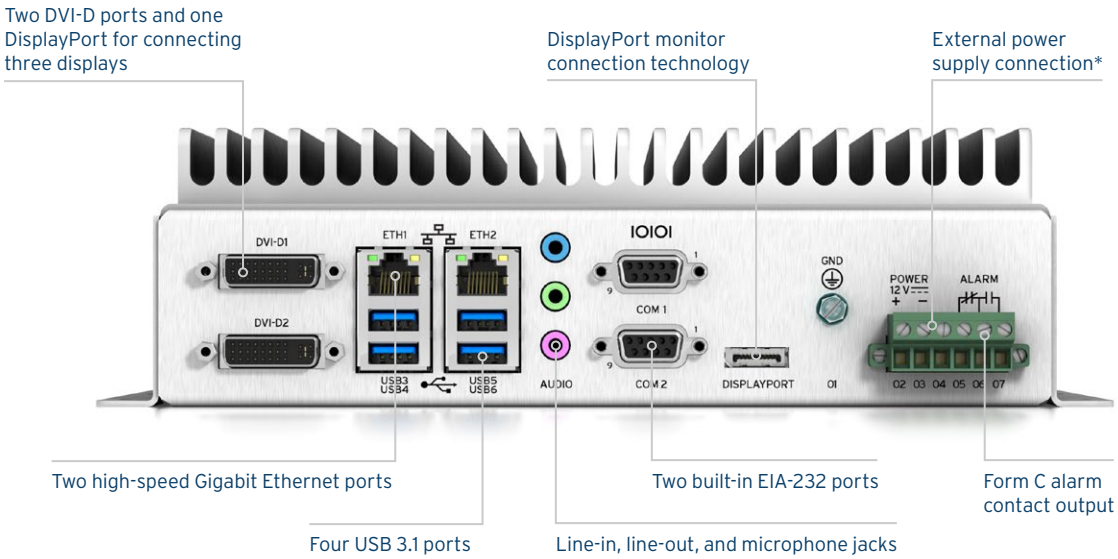
SEL-3360S: $3,145 USD

SEL-3360E: $3,645 USD

selinc.com/products/3360

The SEL-3360 (a compact version of the SEL-3355 Computer with an Intel Xeon E3 quad-core processor) is built to withstand harsh environments in utility substations, industrial control systems, and automation systems. By eliminating all moving parts (including rotating hard drives and fans) and using error-correcting code (ECC) memory technology, SEL compact industrial computers have over ten times the mean time between failures (MTBF) of typical industrial computers. Designed, manufactured, and tested to the same standards as our protective relays, every SEL-3360 comes with a ten-year, worldwide SEL warranty.

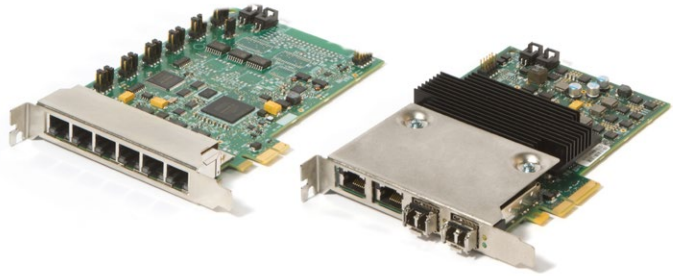




*Add a built-in power supply as well as PCIe expandability with the SEL-3360E (expandable model). The SEL-3360S (standard model) is shown.

SEL-3390

PCIe EXPANSION CARD



Starting Price

SEL-3390E4: $450 USD

SEL-3390S8: $450 USD

selinc.com/products/3390E4 or selinc.com/products/3390S8

The SEL-3390S8 Serial Adapter Card and SEL-3390E4 Ethernet Network Adapter Card are PCI Express (PCIe) expansion cards. The cards are designed, built, and tested for use in harsh industrial and substation environments, providing a wide operating temperature range and immunity to ESD, shock, and vibration. Both cards offer optional conformal coating for corrosion immunity.

The SEL-3390S8 has six software-configurable EIA-232/422/485 ports with RJ45 connectors. All ports meet EIA-562 and are capable of 300 to 921,600 bps with automatic flow control. You can configure each port to provide +5 V to power modems or transceivers.

The SEL-3390E4 has four independent Gigabit Ethernet ports. You can choose all copper, all LC fiber, or two copper and two fiber ports.

SEL-9331

POWER SUPPLY

Starting Price

SEL-9331A: $385 USD

SEL-9331B: $445 USD

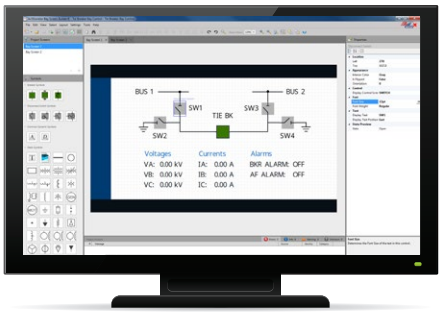
selinc.com/products/9331

The SEL-9331 is a high-output +12 Vdc, 200-watt fanless power supply for SEL industrial computers. It provides ample power in environments where many supplies cannot. The SEL-9331 can produce 11 A of continuous current from −40° to +85°C (−40° to +185°F) and 17 A of maximum current. High-voltage (120/240 Vac or 125/250 Vdc) and low-voltage (48 Vdc) options provide flexibility for a wide range of power sources.

SOFTWARE OVERVIEW

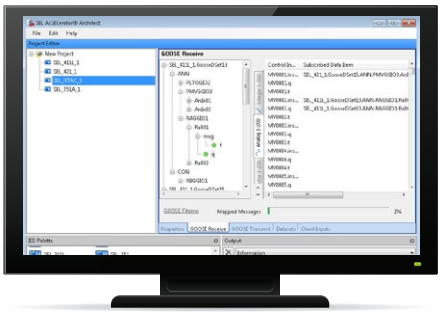
ACSELERATOR QUICKSET®

QuickSet is a tool to quickly and easily configure, commission, and manage devices for power system protection, control, metering, and monitoring.



ACSELERATOR® BAY SCREEN BUILDER

Bay Screen Builder enables the creation of custom bay screens for SEL devices with touchscreen displays.

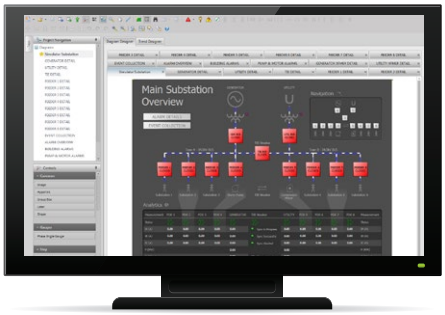


ACSELERATOR ARCHITECT®

Architect streamlines the configuration and documentation of IEC 61850 messages, controls, and reports.

SEL RTAC HMI

The SEL Real-Time Automation Controller (RTAC) HMI offers an easy way to visualize data to monitor and control your system.



ACSELERATOR DIAGRAM BUILDER™

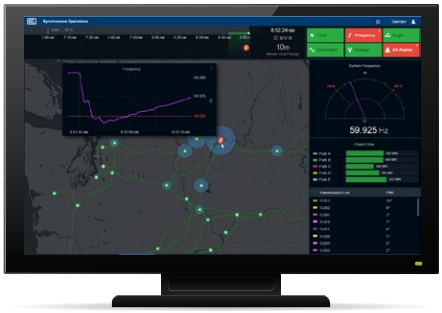
Diagram Builder enables the creation and management of HMI visualization projects for the SEL RTACs in your system.

ACSELERATOR TEAM®

TEAM automates the collection of power system data from multiple devices and stores the data in a central location for easy access.

SYNCHROWAVE® EVENT

SYNCHROWAVE Event allows you to display and analyze SEL relay event reports and COMTRADE files.



SYNCHROWAVE OPERATIONS NEW

SYNCHROWAVE Operations delivers wide-area visualization and analytics solutions for real-time power system operations.

SOFTWARE-DEFINED NETWORK FLOW CONTROLLER

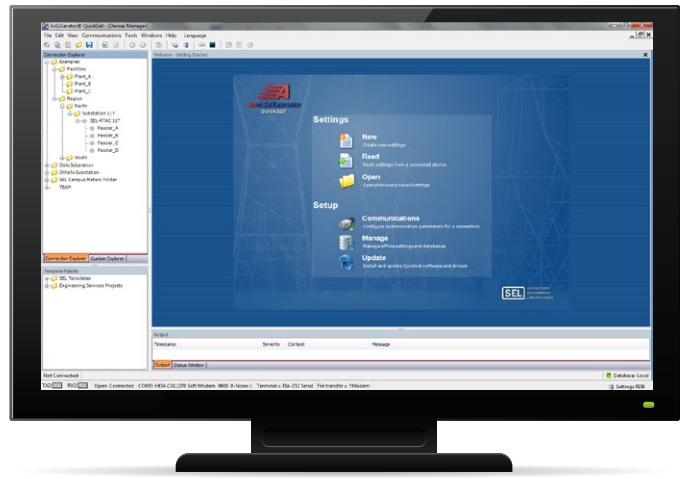
The SEL-5056 Flow Controller is the central interface for the commissioning, configuration, and monitoring of all SEL SDN-enabled network appliances.

SEL-5030

ACSELERATOR QUICKSET® SOFTWARE

Included With Supported Products

selinc.com/products/5030



QuickSet is a tool to quickly and easily configure, commission, and manage devices for power system protection, control, metering, and monitoring.

Streamlined Settings Creation and Validation—View the logical settings groups presented by QuickSet to quickly identify related device settings. QuickSet automatically verifies these settings to ensure they are in range and permitted.

Reduced Logic Design Time—Generate custom logic with the Graphical Logic Editor (GLE). To simplify logic configuration in supported relays, QuickSet offers drag-and-drop tools for creating diagrams and SELOGIC® control equations specific to your application.

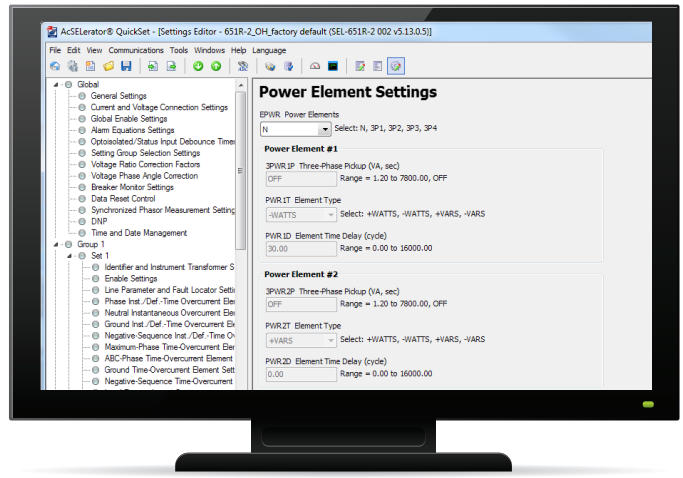
Device Performance Monitoring—Use the device HMI within QuickSet to manage and monitor system values. This is ideal for ensuring proper device performance during commissioning.

Centralized Device Management—Organize the numerous devices and their related data in a central location with the Device Manager plugin, enabling improved collaboration.

Standardized New Device Deployment—Reduce human error when deploying new devices by using the Template Palette. Predefined templates that match your company's standards make it easy to configure new devices.

Improved Configuration Collaboration—The Device Manager reduces the time spent with device configuration management and oversight by reconciling collaborator versions using the built-in compare tool.

File Version Management—Control versions of settings in a centralized database. The Device Manager lets you create setting baselines, generate comparison reports between setting versions, and meet regulatory requirements.



QUICKSET ORDERING OPTIONS

Design Templates
Create settings templates for uniform device design.

Device Management for Workgroups
Collaborative access to Device Manager data.

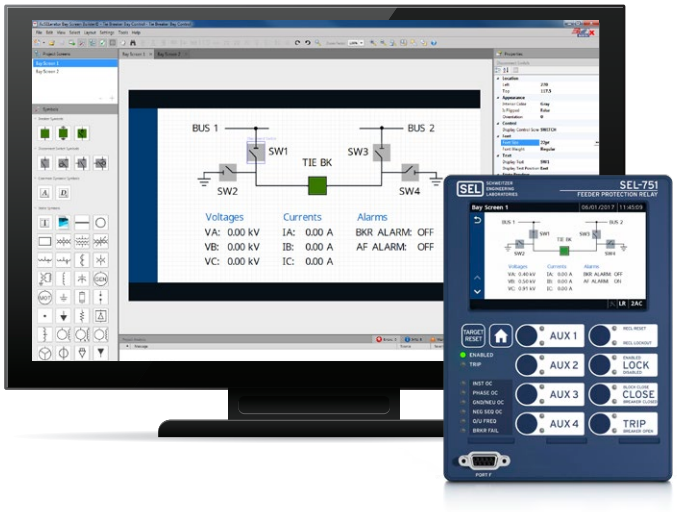
For the list of supported products, visit **selinc.com/5030products**.

SEL-5036

ACSELERATOR® BAY SCREEN BUILDER SOFTWARE

Included With ACSELERATOR QuickSet® SEL-5030 Settings Driver for Supported Products

selinc.com/products/5030



Bay Screen Builder is a Microsoft Windows application that lets you create custom bay screens for SEL devices with touchscreen displays. It works with QuickSet, enabling you to take control of bay screen design and management.

Try a free copy of Bay Screen Builder by downloading it using SEL Compass®, available at **selinc.com/products/compass**.

Standalone, Device-Integrated, Customized Control and Monitoring—Leverage the rich, easy-to-use repository of ANSI and IEC symbols in the Bay Screen Builder for a variety of bay screen designs. The software natively supports English, French, German, Italian, Portuguese, Russian, and Spanish. You can deploy bay screens anywhere using fixed images containing other languages.

Efficient Bay Screen Design Standardization—Collaborate on and share Bay Screen Builder projects for standardization, and readily update standards by customizing existing designs.

SEL System Integration Via Simple Interface—Launch Bay Screen Builder from within QuickSet for user-friendly access to all items necessary for the bay screen design.

All bay screen editing and management tasks initiate with one button in QuickSet. The bay screens download to the target SEL devices when you send settings.

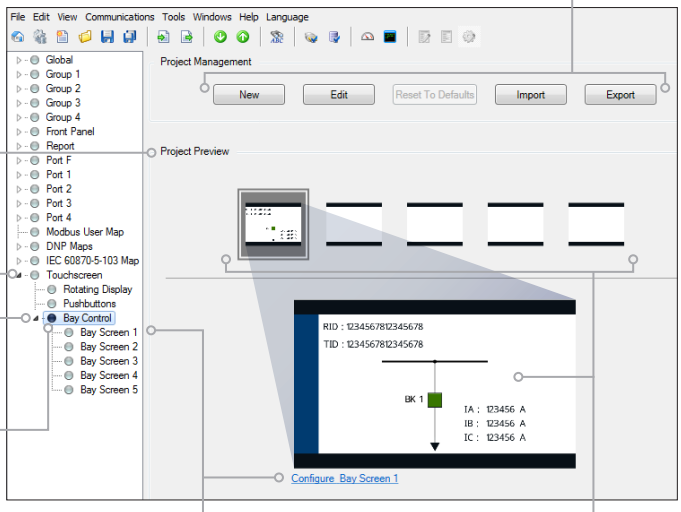
Save time and improve efficiency by sharing Bay Screen Builder projects containing relevant bay screens. Customize the bay screens further for your application by editing the existing ones or creating new ones.

Preview bay screens in the device QuickSet Settings Editor.

Expand to access touchscreen display and bay control items.

Expand to access up-to-date bay screens in the device QuickSet Settings Editor.

Click to access Project Management and Project Preview panes.



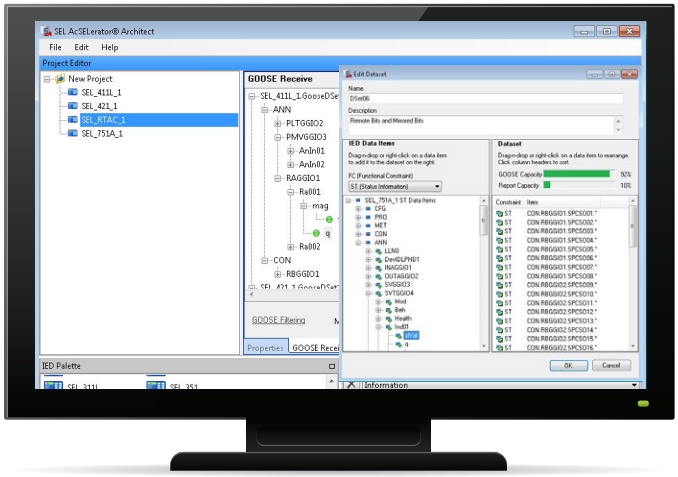
Click to access QuickSet settings for symbols located on the selected bay screen.

Choose a device bay screen to preview from the overview.

SEL-5032
ACSELERATOR ARCHITECT® SOFTWARE

Included With Supported Products

selinc.com/products/5032



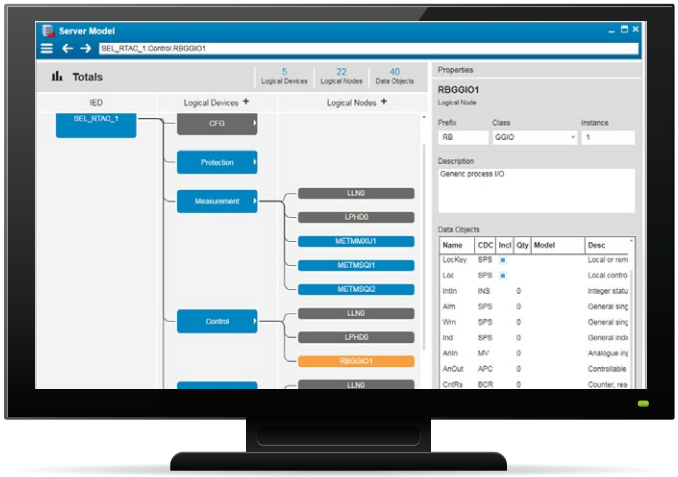
Substation communications networks using the IEC 61850 Manufacturing Message Specification (MMS) and GOOSE protocols require a systemic methodology to configure message publications and subscriptions. Architect is a Microsoft Windows application that streamlines the configuration and documentation of IEC 61850 control and SCADA communications.

Simple Device Integration—Configure SEL devices in IEC 61850 installations using ACSELERATOR QuickSet® SEL-5030 Software and Architect together. Architect provides a means to configure and document the IEC 61850 communications settings between SEL devices and devices from multiple manufacturers.

- Import and export Edition 1 and Edition 2 Substation Configuration Language (SCL) files to simplify system implementation.
- Detect and report errors by automatically comparing SCL files with the IEC 61850 requirements. SCL files include:
  - SCD—Substation Configuration Description.
  - ICD—IED Capability Description.
  - CID—Configured IED Description.
- Easily apply the software with:
  - Drag-and-drop functionality.
  - IED palette manager.
  - Tab orientation.
  - Diagnostic windows.
  - Settings wizard.
- Create and edit custom buffered and unbuffered MMS reports.
  - Configure the publications and subscriptions for IEC 61850-9-2LE Sampled Values.
  - Create and organize custom logical devices.

Server Model Editor—The SEL Real-Time Automation Controller (RTAC) includes MMS server capability that expands its very flexible data concentration capabilities. In systems where the RTAC needs to transmit SCADA data from various client protocol connections (such as SEL, Modbus, or DNP3) in MMS messages, Architect includes the Server Model Editor for configuring MMS server instances in RTACs.

The Server Model Editor provides a graphical representation of the RTAC server model, which enables quick visualization and convenient editing tools for creating and maintaining MMS server applications.



SEL RTAC HMI

WEB-BASED HMI PACKAGE FOR RTACs

Starting Price
$1,750 USD

The SEL Real-Time Automation Controller (RTAC) supports an optional web-based HMI system that is well-suited for use in substations and for small processes. The SEL RTAC HMI offers an easy way to visualize data to monitor and control your system without special software.

Order the RTAC HMI as an option with new RTACs, or enable it via a field upgrade.

Situational Awareness and Control—Efficiently monitor and control substation performance and critical industrial processes. The RTAC HMI helps you detect changing system conditions, misoperations, and early warning signs so you can make informed real-time decisions as well as plan maintenance for improved system reliability.

Browser-Based Secure Local and Remote Access—Access the RTAC HMI locally or remotely via a web browser interface hosted on the web server on the RTAC unit. The HMI provides secure, role-based, authenticated access for multiple users from multiple locations. The HMI runtime system is rendered using the HTML5 standard; no plugins are required on compatible browsers.

Integrated Video Provides Visualization With SEL-3555 and SEL-3560—Resolve your need for automation processing and HMI visualization by using the integrated video and USB ports in the high-performance SEL-3555 and SEL-3560 RTACs for local display of the HMI.

Alarm Notification—Alert the operators when there is a problem by using the integrated Sequence of Events (SOE) viewer and customizable alarm annunciation.

Instant Feedback and Advanced Warning—Design trends dynamically in the HMI runtime system to display any value over time, enabling operators to be proactive and make more-informed control decisions.

SEL System Integration—Monitor, control, and analyze your system more efficiently with on-demand, secure, web-based access from anywhere, anytime.

SEL-5035

ACSELERATOR DIAGRAM BUILDER™ SOFTWARE

Included With RTAC HMI Purchase

selinc.com/products/5035

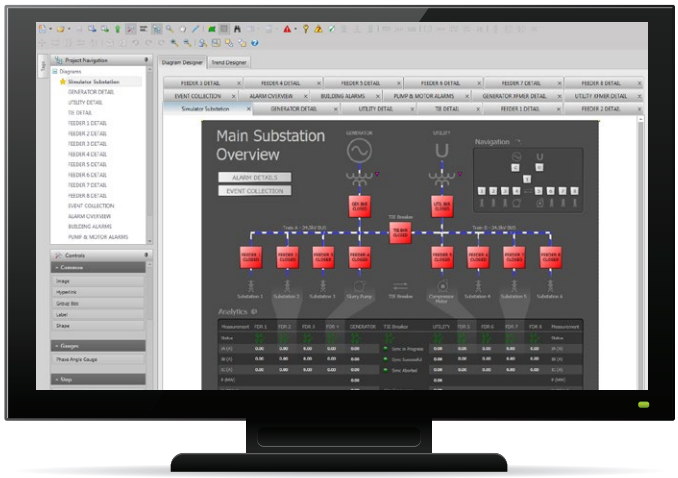


Diagram Builder is a Microsoft Windows application that allows you to create and manage HMI visualization projects in the SEL RTAC HMI for all of the SEL Real-Time Automation Controllers (RTACs) in your system.

Try a free copy of Diagram Builder by downloading it from the product webpage or by using SEL Compass®, available at **selinc.com/products/compass**.

Process Overview—Efficiently design process overview screens to rapidly gather information regarding the health of your processes. Diagram Builder includes predesigned graphical objects and freehand tools for easy screen development.

Substation Control—Provide consistent power system control screens using the dynamic power system objects loaded in Diagram Builder.

Alarm Management—Quickly design professional-quality, customized alarm screens with alarm management objects to provide the right alarm information at the right time.

Operation Improvement and Troubleshooting—Use the trend designer to predefine trend displays so system engineers can more easily understand process behaviors and perform detailed root-cause analysis. Additionally, you can dynamically design trends in the HMI runtime system to display any value over time. These trends can help you avoid future system faults and failures.

Simplified Tag Mapping and Management—Import tags from an existing RTAC project using a simple user interface to save time and effort. You can quickly find the tag you need using an intuitive tag list in Diagram Builder.

SEL System Integration—Send a Diagram Builder project to an RTAC and access the HMI from anywhere with a network connection to the RTAC through a convenient web interface. The HMI runtime system is rendered using the HTML5 standard.

System Diagram Customization—Design every aspect of a diagram, such as the background, colors, and fonts. Layout tools help you keep it all organized.

SEL-5045

ACSELERATOR TEAM® SOFTWARE

Starting Price
$2,500 USD

selinc.com/products/5045

TEAM automates the collection of power system data from multiple devices and stores the data in a central location for easy access. When something happens, whether it's a relay trip, system fault, or security notification, TEAM is ready to help with continuous background monitoring, collection, notification, and storage. This ensures that the data are there when you need them to help discover root cause, maintain records for regulatory compliance, and keep your system running at peak efficiency.

TEAM operates as a set of Microsoft Windows services that continuously collects data from devices. All collected data are stored either in the ACSELERATOR® Database (a PostgreSQL database) or at a specified disk location.

TEAM functionality is licensed as four feature sets: TEAM Event, TEAM Profile, TEAM Security, and TEAM Transmission Fault Location (TFL). You can select from the four feature sets to build a TEAM application that best suits your system needs.

View multiple ACSELERATOR Databases, and securely provide read-only access to TEAM-collected data.

Access information about your TEAM installation from a network-connected computer. You can verify Windows services, installed versions, and licensing information and review service logs.

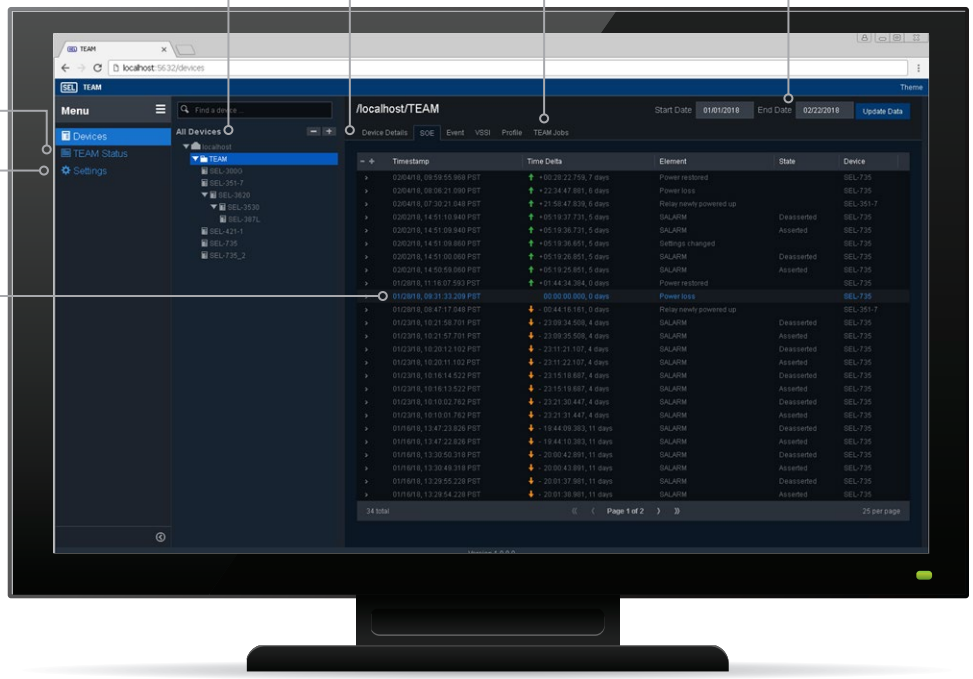
From the Settings page, enable additional TEAM databases and set the time zone for data viewing.

Set a time reference point by simply selecting a data row. The Time Delta adjusts based on the selected row to quickly evaluate the order of operations.

Easily view device configuration attributes with a read-only view organized in a tabbed menu.

View and verify TEAM configurations for enabled jobs. You can view the polling frequency, when the job was last executed, and other configuration information.

Easily adjust the date range.



TEAM EVENT

TEAM Event makes capturing, evaluating, and sharing event data easy. It automatically captures event data from supported SEL and third-party devices in CEV, COMTRADE, and Sequence of Events (SOE) formats. With TEAM Event, you can designate a query interval for TEAM to periodically query devices for new data. For enhanced data collection speeds, you can integrate TEAM with SEL Real-Time Automation Controllers (RTACs). An RTAC provides secure notifications to TEAM of new events and SOE data available for collection.

Oscillographic event data are beneficial for system monitoring, fault analysis, and troubleshooting purposes. With the Web Viewer, Timeline Viewer, Event Viewer, and SOE Viewer in TEAM Event, you can quickly review oscillographic data and identify important events by type, device, location, or timeline.

TEAM Sync, included with TEAM Event, securely transports event and SOE data between database storage locations for automated data redundancy. TEAM Event can also notify appropriate individuals of new system events through TEAM's automatic email or SMS text messaging.

TEAM PROFILE

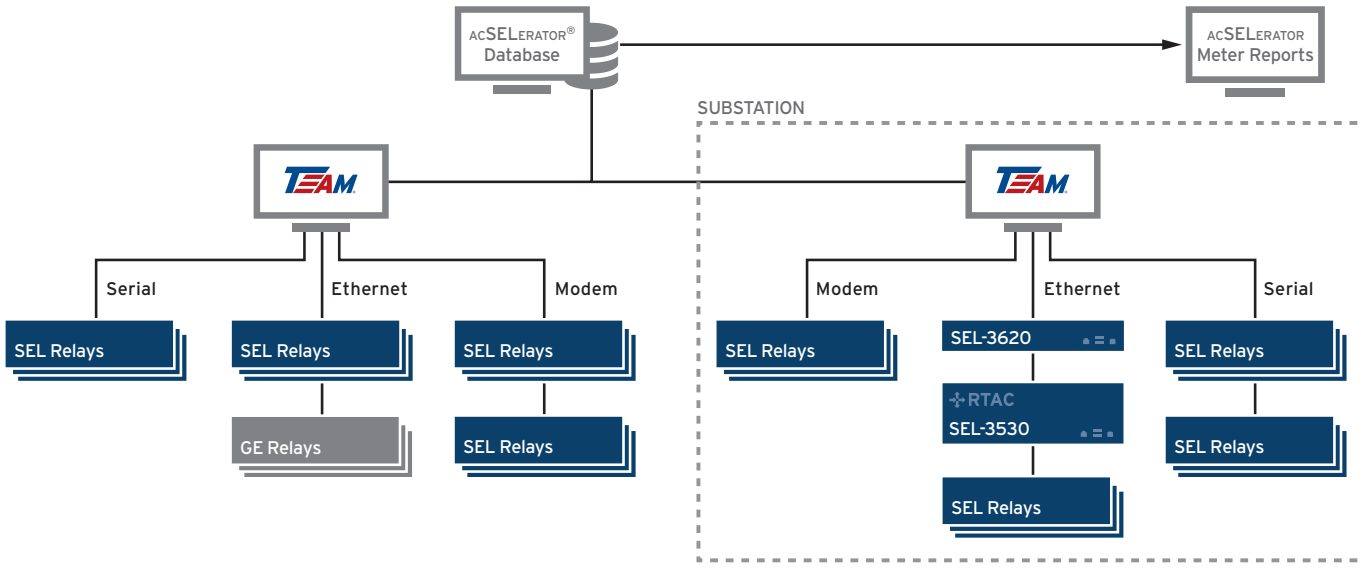
Load data profiling (LDP) information contains energy, demand, voltage, current, harmonic, and frequency trends that are useful when managing a large metered area. TEAM Profile automates the collection of LDP and voltage sag, swell, and interruption (VSSI) data from SEL-734 Revenue Meters, SEL-735 Power Quality and Revenue Meters, and SEL-751A Feeder Protection Relays. With the RTAC Trend Recorder library, you can record IED quantities, collect them with TEAM Profile, and trend them with ACSELERATOR Meter Reports SEL-5630 Software. You can view meter-generated data with Meter Reports to graph forensic data.

TEAM SECURITY

Use TEAM Security to automate password management and maintain a central repository of managed-device interactions and password reports for disaster recovery. TEAM Security works with the SEL-3620 Ethernet Security Gateway and the SEL-3622 Security Gateway to rotate device passwords on a set interval. When configured, TEAM Security also collects the device commands and the password management and Syslog reports generated by the SEL-3620, SEL-3622, and SEL-3025 Serial Shield® after new passwords are generated or on a specified interval.

TEAM TFL

Quickly restoring power after a system fault is a top priority. TEAM expedites accurate fault locating and can email or text results to appropriate individuals. Most digital protective relays or other IEDs use local or single-ended measurements to determine the fault location. To increase accuracy, TEAM TFL uses a two-terminal fault-locating method based on event information collected at the transmission line's end terminals. When a fault occurs, TEAM TFL receives time-stamped event reports from IEDs or digital fault recorders (DFRs) at both terminals of a transmission line, checks to see if the events are associated with any of the configured lines, time-aligns the event records, and executes a two-terminal fault-locating algorithm.



TEAM works with multiple devices in a variety of configurations to meet your system needs.

SEL-5601-2

SYNCHROWAVE® EVENT SOFTWARE

Starting Price
$500 USD

selinc.com/products/5601-2

SYNCHROWAVE Event helps diagnose a protective relay's behavior during a power system fault. It is a powerful yet easy-to-use solution for displaying and analyzing SEL relay event reports and COMTRADE files.

Analyze Relay Event Data—Plot relay oscillography, display phasor magnitudes and angles, and monitor the digital status. You can navigate through events with integrated zoom and pan functions.

Time-Align Event Reports—Easily coordinate multiple event report times for accurate comparison and analysis of signals from multiple relays or past event reports.

Perform Calculations—Create equations to analyze specific trip conditions. For quick event analysis, you can instantly plot calculation results. The built-in function library offers endless calculation possibilities.

Visualize Distance Elements—Analyze protective relay distance element operation with the exact mho circle diagram. The diagram lets you plot and analyze apparent impedance and distance element characteristics.

Save Analysis Setup Time—Create personal and relay-specific analysis templates for a custom view into the relay's operation. For more efficient post-event analysis, you can save and share templates.

See Traveling Waves—Both the SEL-T400L Time-Domain Line Protection and the SEL-411L Advanced Line Differential Protection, Automation, and Control System can record traveling-wave data to provide a highly accurate fault location. SYNCHROWAVE Event generates a Bewley lattice diagram from the traveling-wave data to enable visualization, analysis, and understanding of the traveling waves recorded for an event.

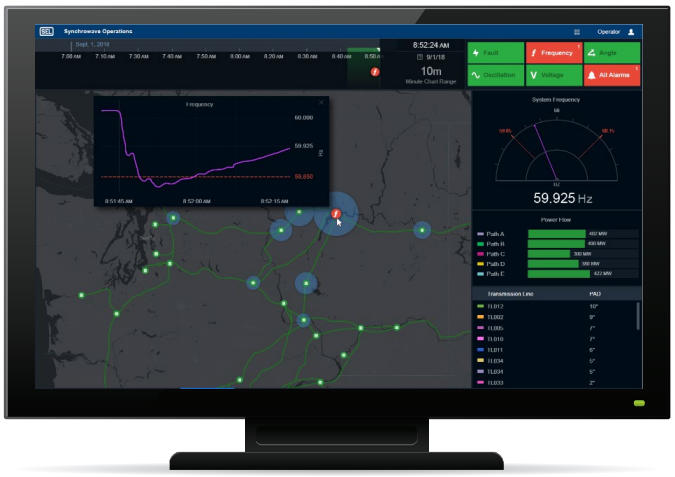
For more information on traveling-wave fault locating, see the technical paper "Locating Faults by the Traveling Waves They Launch," available at **selinc.com**.

SYNCHROWAVE Event generates Bewley lattice diagrams from traveling-wave data to enable visualization and analysis.

SYNCHROWAVE® OPERATIONS NEW

SOFTWARE

Contact SEL for More Information



SYNCHROWAVE Operations is a wide-area visualization and analytics solution for real-time power system operations. The software is part of the SYNCHROWAVE platform, which provides cybersecurity, redundancy for reliability, and scalability for performance. Modular feature applications simplify system integration with your operations center software infrastructure.

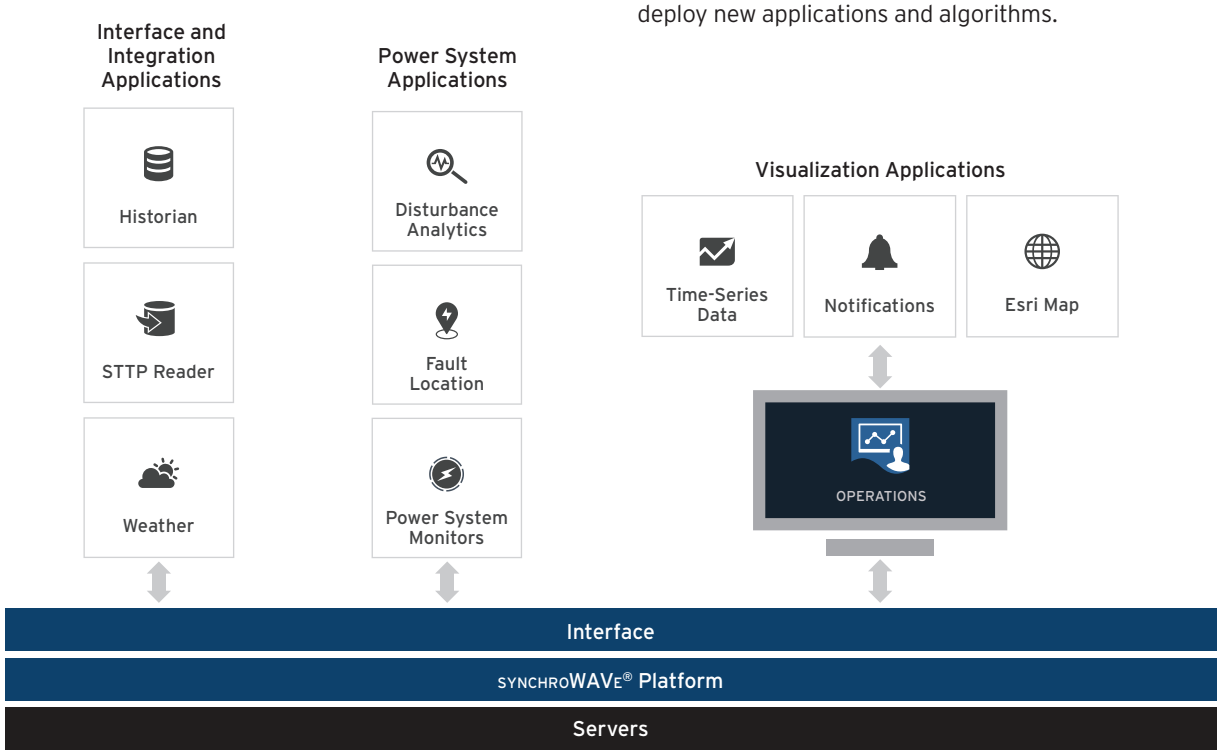
Situational Awareness—Dashboards collect power system data and information into a single display. Information is organized and presented based on the present power system state. The flexible dashboards simplify the operator workflow and ensure the right information is displayed at the right time.

Real-Time Analytics—Real-time analytics applications continuously analyze sources of data to detect and characterize power system conditions. Upon detecting a specified condition, monitoring applications provide information about the location and impact.

Synchrophasors and Time-Domain Data—SYNCHROWAVE is the only wide-area situational awareness platform supporting both synchrophasors and streaming time-domain point-on-wave data. Direct point-on-wave measurements can stream at rates as fast as 10,000 samples/second.

High-Performance Platform—The SYNCHROWAVE platform brings modern data center technology to utility private networks. The platform is built with microservice and container technology. The result is a robust and scalable platform that supports future growth.

Open Platform—Published interfaces simplify the integration of applications, enabling you to quickly create, integrate, and deploy new applications and algorithms.



WAN AND LAN NETWORKS OVERVIEW

SEL ICON®

The SEL ICON is a WAN multiplexer optimized for industrial and utility applications. By combining TDM and Ethernet transport options with a comprehensive range of data interfaces, the ICON makes it easy to migrate legacy network technologies to a packet-based solution.

SEL-2740S

The SEL-2740S is the industry's first field-hardened software-defined networking (SDN)-enabled switch and improves Ethernet performance in mission-critical applications.

SEL-2742S NEW

The SEL-2742S is a 12-port, DIN-rail mount SDN switch for industrial environments. It combines with SEL-5056 Flow Controller Software to simplify network engineering and improve LAN security.

SEL-3620/3622

The SEL-3620 and SEL-3622 each function as a router, VPN endpoint, and firewall device. They can provide secure and proxy user access for serial- and Ethernet-based intelligent electronic devices (IEDs).

SEL-2730M/2730U

The SEL-2730M/2730U let you build reliable, safe Ethernet networks in electrical substations, plants, and other mission-critical sites.

SEL-3610

The SEL-3610 increases the number of serial ports available to communications processors and computers and allows serial products to communicate securely through Ethernet networks.

SEL-2725

The SEL-2725 allows you to easily connect devices to Ethernet networks.

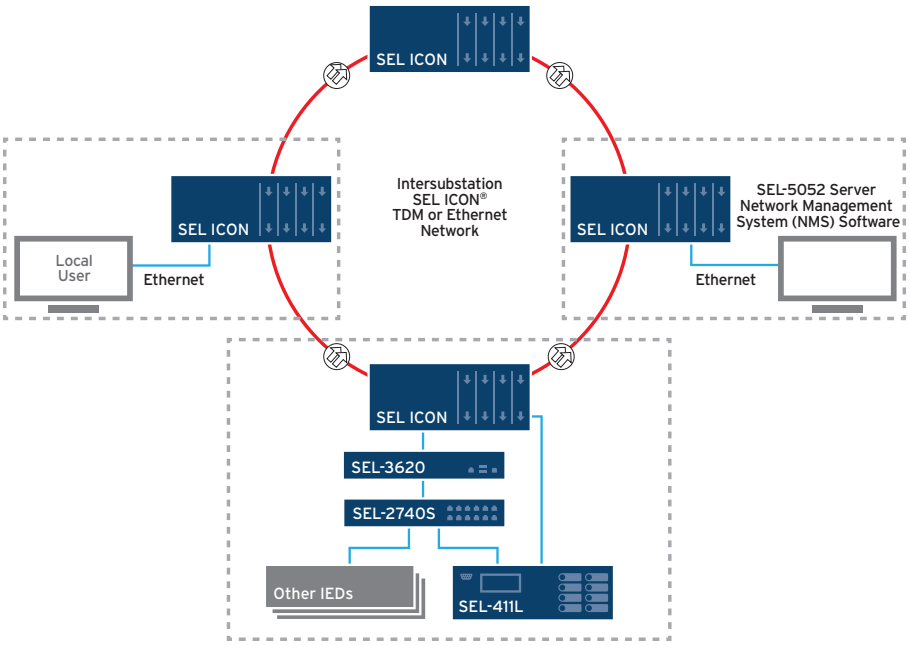
SEL-3025

The SEL-3025 protects serial communications with bump-in-the-wire security and strong, authenticated access controls.

	SEL ICON®	SEL-3620	SEL-3622	SEL-3610	SEL-2725	SEL-2730M	SEL-2740S	SEL-2742S	SEL-2890
APPLICATIONS									
SONET WAN	•								
Ethernet LAN	•	•	•	•	•	•	•	•	•
Precise Time Distribution	•	•	•	•			•	•	
Engineering Access Control		•	•	•					
Connect Multiple Wired-Ethernet Devices to Network	•				•	•	•	•	
Convert Wired 10/100BASE-T Ethernet to Fiber-Optic 100BASE-FX Ethernet	•	•	•	•	•	•	•	•	
Convert Serial Links to Ethernet Links		•	•	•					•
FEATURES									
Cryptography (Encryption and Authentication)	•	•	•	•					
User-Based Accounts	•	•	•	•		•	•	•	
Centralized Authentication Via Lightweight Directory Access Protocol (LDAP)	•[8]	•	•	•		•	•	•	
Centralized Authentication Via Remote Authentication Dial-In User Service (RADIUS)		•	•	•		•			
Deny-by-Default Firewall		•	•						
Import/Export Configuration Files		•	•	•		•	•	•	
VPN		•	•						
Syslog Logging	•	•	•	•		•	•	•	
Network Management System (NMS) Software	•					•	•	•	
GPS Receiver	•								
Real-Time Latency Monitor	•								
Spanning Tree Protocol (STP)		•	•	•		•[1]			
VLANs	•	•	•	•		•	•	•	
Ethernet Class of Service	•					•	•	•	
ETHERNET PORTS, CONNECTOR	**QUANTITIES**								
Copper 10BASE-T, RJ45									1
Copper 10/100BASE-T, RJ45	0–16[2]	3	3	3	3–5	0–16[3]	0–20	2–10	
Fiber-Optic 100BASE-FX, LC	4	2	2	2	0–2	0–16[3]	0–20	0–6	
Copper Gigabit Ethernet (GigE), RJ45	4					4	0–4	0–4	
Fiber-Optic GigE, LC	2[6]/4[7]					0–4[4]	0–4	0–4	
Small Form-Factor Pluggable (SFP) Cages	2–6[5]					4[4]			

[1]SEL-2730M supports STP plus IEEE 802.1D-2004 Rapid Spanning Tree Protocol (RSTP).
[2]SEL ICON can support up to 16 Ethernet ports using 8-port Ethernet Access Modules or Ethernet Bridging Access Modules.
[3]SEL-2730M base configuration supports sixteen 10/100BASE-T copper ports, with the option to substitute 100BASE-FX fiber-optic ports in groups of four.
[4]SEL-2730M base configuration includes 4 copper GigE ports and 4 SFP cages for optional fiber-optic GigE ports.
[5]SEL ICON uses SFP cages for SONET and GigE fiber-optic interfaces.
[6]SEL-8021-1 Line Module supports 2 fiber-optic Gigabit interfaces.
[7]SEL-8036-1 Ethernet Bridging Access Module supports 4 fiber-optic 100BASE-FX/Gigabit interfaces.
[8]SEL-5052 Server NMS Software provides LDAP centralized authentication for the ICON.

WAN AND LAN NETWORKS APPLICATIONS

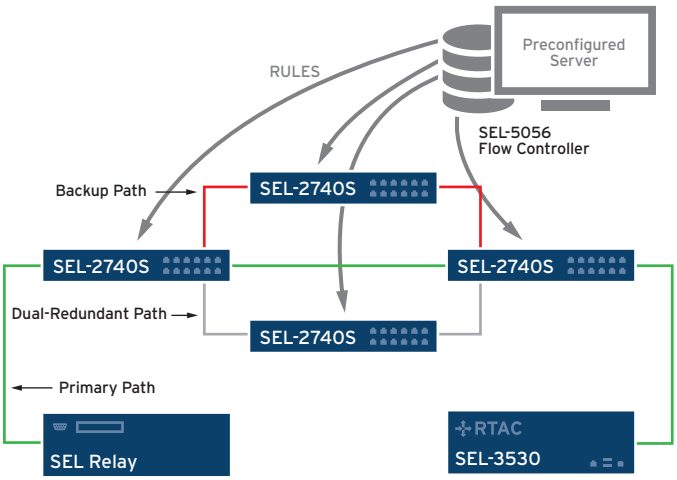


MAINTAINING CRITICAL SERVICES BETWEEN SITES

Install the SEL ICON® Integrated Communications Optical Network to maintain critical services between sites by quickly restoring traffic when an infrastructure disruption, like fiber failure, occurs.

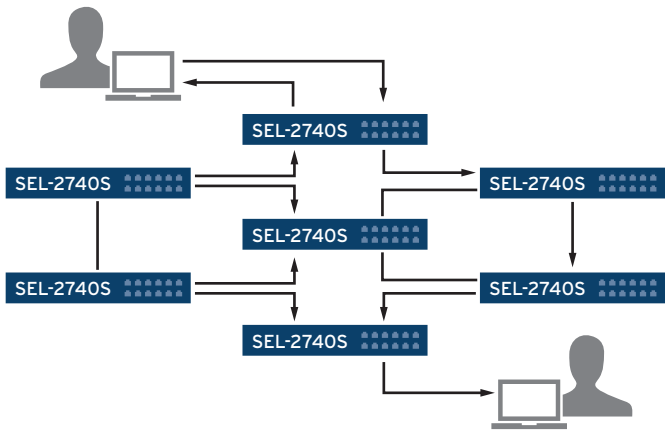
You can configure the ICON to operate as a SONET or Ethernet multiplexer to address the following network use cases:

- Segregated operational technology (OT)—SONET transport (shown here)
- Segregated OT—Ethernet transport
- Converged IT/OT—Multiprotocol Label Switching (MPLS) or Carrier Ethernet core network
- Analog leased line service migration



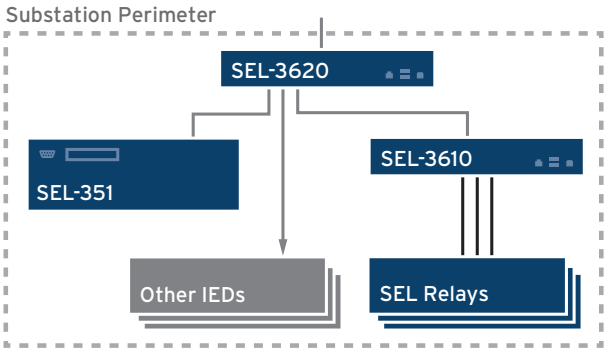
IMPROVING MISSION-CRITICAL ETHERNET PERFORMANCE

The breakthrough software-defined networking (SDN) technology in the SEL-2740S Software-Defined Network Switch solves the inherent limitations of Ethernet networks. Every network path is predefined by the user, enabling precise control over how the system responds to network failures. The SEL-2740S fails over in less than 100 µs, ensuring the performance of mission-critical applications under all conditions. This means no more waiting for discovery or convergence times.



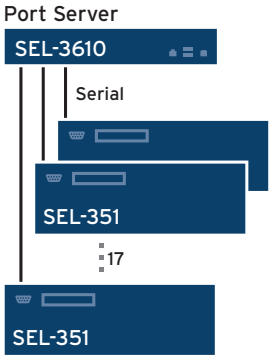
REDEFINING SECURITY FOR ETHERNET NETWORKS

The deny-by-default architecture of the SEL-2740S means only preapproved traffic that matches specific rules is allowed onto the network. The switch inspects multiple layers of every packet to see if they match the set of rules you define. If there is a mismatch, the SEL-2740S can immediately drop the packet or forward it to an intrusion detection system for in-depth analysis. In addition, you can change these rules at any time.



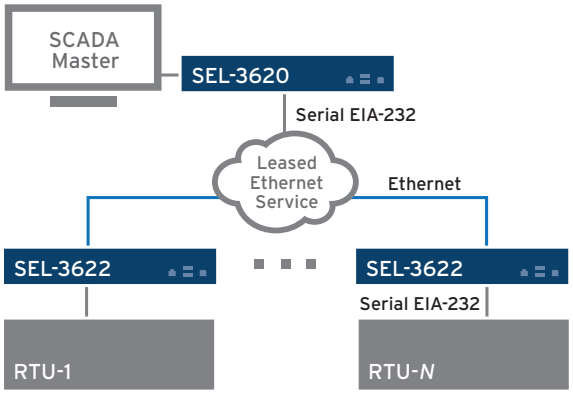
MANAGING AND SECURING SYSTEM COMMUNICATIONS

Install the SEL-3620 Ethernet Security Gateway to secure your control system communications with a stateful deny-by-default firewall, strong cryptographic protocols, and logs for system awareness. The SEL-3620 also manages protected intelligent electronic device (IED) passwords and helps create a user audit trail through strong, centralized, user-based authentication and authorization for modern and legacy IEDs.



CONNECTING TO SEL PRODUCTS AND OTHER DEVICES FOR SECURE SERIAL COMMUNICATIONS

Add 17 serial ports with the SEL-3610 Port Server to connect SEL products and other devices and allow secure serial communications through Ethernet networks. The SEL-3610 tunnels serial data over an Ethernet connection using Secure Shell (SSH), Telnet, Modbus, or raw TCP encapsulation. The SEL-3610 allows you to restrict all access to unconfigured logical and physical ports.



MANAGING TRANSITION FROM ANALOG TO ETHERNET LEASED LINE SERVICES

Apply the bit-based serial conversion technology in the SEL-3620 and SEL-3622 Security Gateways to seamlessly convert existing bit-based serial protocols, such as Conitel, Tejas, Van Comm, and Redaj, to Ethernet packets on the near side of a link. Then, reconvert that Ethernet data back into bit-based form on the remote side. This allows the SEL-3620 and SEL-3622 to serve as drop-in replacements for analog line-to-line modem technology without disrupting existing equipment and with minimal additional latency.

SEL ICON®

INTEGRATED COMMUNICATIONS OPTICAL NETWORK

Starting Price

SEL-8001-01 19-Inch Rack-Mount Chassis: $920 USD

SEL-8002-01 8-Inch DIN-Rail Chassis: $450 USD

SEL-5051 Client Network Management System (NMS) Software: $5,000 USD

SEL-5052 Server NMS Software: $5,000 USD

Note: Chassis requires power module and at least one application module.

selinc.com/products/ICON

The SEL ICON is a WAN multiplexer optimized for industrial and utility applications. You can configure the ICON to operate as a SONET or Ethernet multiplexer to address the following network usage cases:

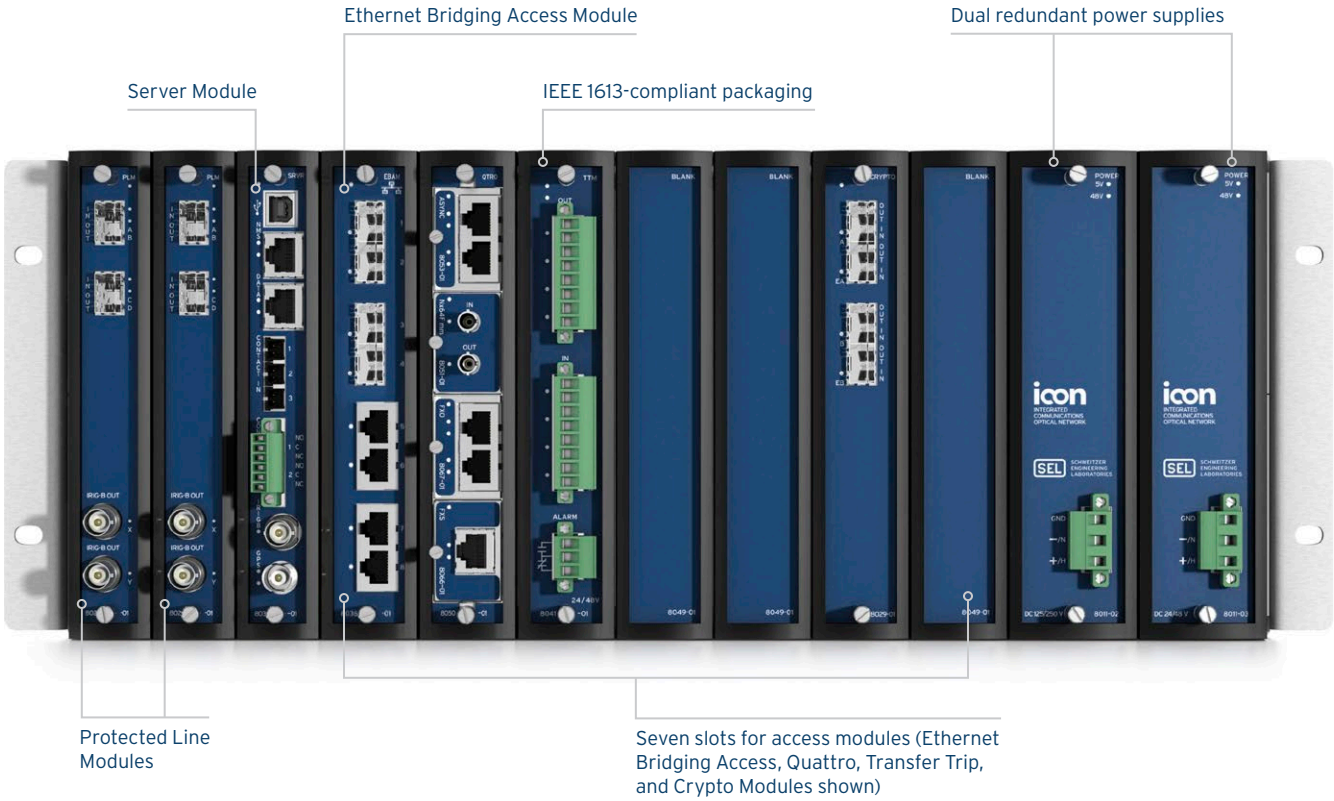
- Segregated operational technology (OT)—SONET transport
- Segregated OT—Ethernet transport
- Converged IT/OT
- Analog leased line service migration

The virtual synchronous networking (VSN) technology in the ICON preserves the performance characteristics of time-division multiplexing (TDM) when converting to Ethernet as a transport protocol. By combining TDM and Ethernet transport options with a comprehensive range of data interfaces, the ICON makes it easy to migrate legacy network technologies to a converged IT/OT packet-based solution. The ICON interoperates with Multiprotocol Label Switching (MPLS) or Carrier Ethernet core networks to provide a hardened OT edge multiplexer for mission-critical applications.

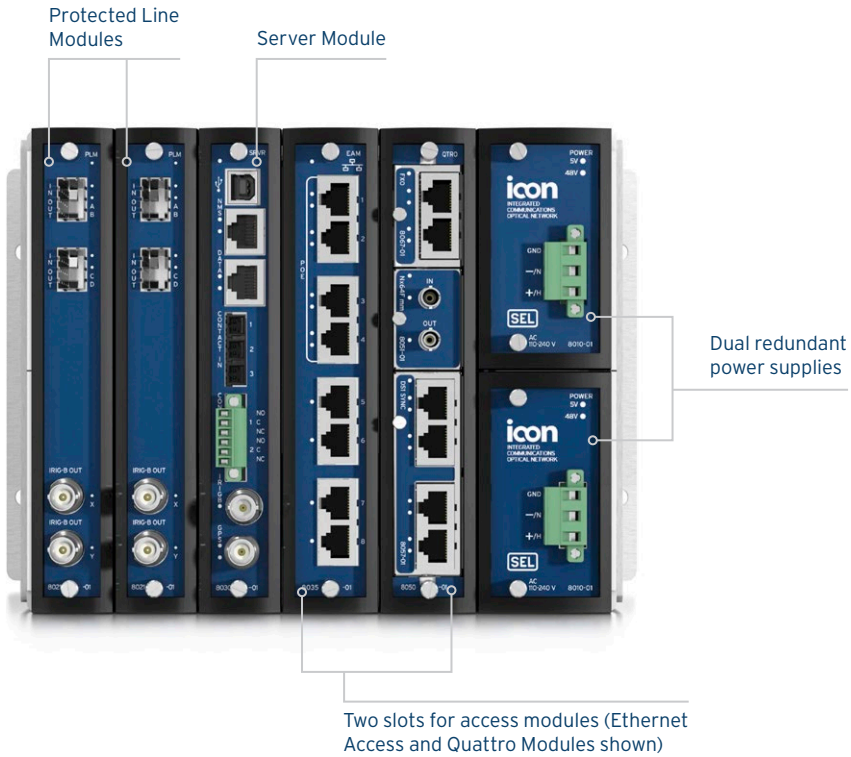
SEL-5051 Client and SEL-5052 Server NMS Software help you maintain a secure, reliable, and efficient communications infrastructure. In the client-server architecture, the SEL-5051 Client Software connects to the SEL-5052 Server Software to provide an efficient solution for managing network access for multiple users. The SEL-5052 Server Software offers centralized user security, settings, alarms, and event management.

ICON MODULES

PART NUMBER	DESCRIPTION	STARTING PRICE
Power Modules		
8011-02	19-Inch Rack Power Module, High-Voltage AC/DC, 120–240 V, 92 W	$400
8010-02	8-Inch Cube Power Module, High-Voltage AC/DC, 120–240 V, 63 W	$350
Control Modules		
8020-01	Line Module	$2,030
8021-01	Protected Line Module	$1,500
Server Module		
8030-01	Server Module	$600
Access Modules		
8035-01	Ethernet Access Module	$700
8036-01	Ethernet Bridging Access Module	$1,000
8041-01	Transfer Trip 4-Function 24/48 VDC TX/RX Teleprotection Module	$1,200
8041-04	Transfer Trip 4-Function 125/250 VDC TX/RX Teleprotection Module	$1,200
8050-01	Quattro Module (accepts 2 DS1 or 4 non-DS1 submodules)	$208
8051-01	Nx64F IEEE C37.94 Multimode Quattro Submodule	$216
8051-02	Nx64F IEEE C37.94 Single-Mode Quattro Submodule	$480
8053-01	Async Data Quattro Submodule	$204
8055-01	422 Sync Quattro Submodule	$375
8056-01	G.703 Quattro Submodule	$375
8057-01	DS1 Async (Quad DS1 Ports) Quattro Submodule	$450
8057-02	DS1 Sync (Quad DS1 Ports) Quattro Submodule	$800
8057-03	DS1 Psync (Quad DS1 Ports) Quattro Submodule	$800
8065-01	4-Wire VF Dual Ports Quattro Submodule	$320
8066-01	FXS Single-Port Quattro Submodule	$320
8067-01	FXO Dual-Port Quattro Submodule	$320
Encryption Module		
8029-01	Crypto OC-48 Module	$3,000



The ICON is available in a standard 19" rack-mount chassis or in a compact ICON Cube package for limited-space applications.



SEL-2740S

SOFTWARE-DEFINED NETWORK SWITCH

Starting Price

SEL-2740S: $3,750 USD

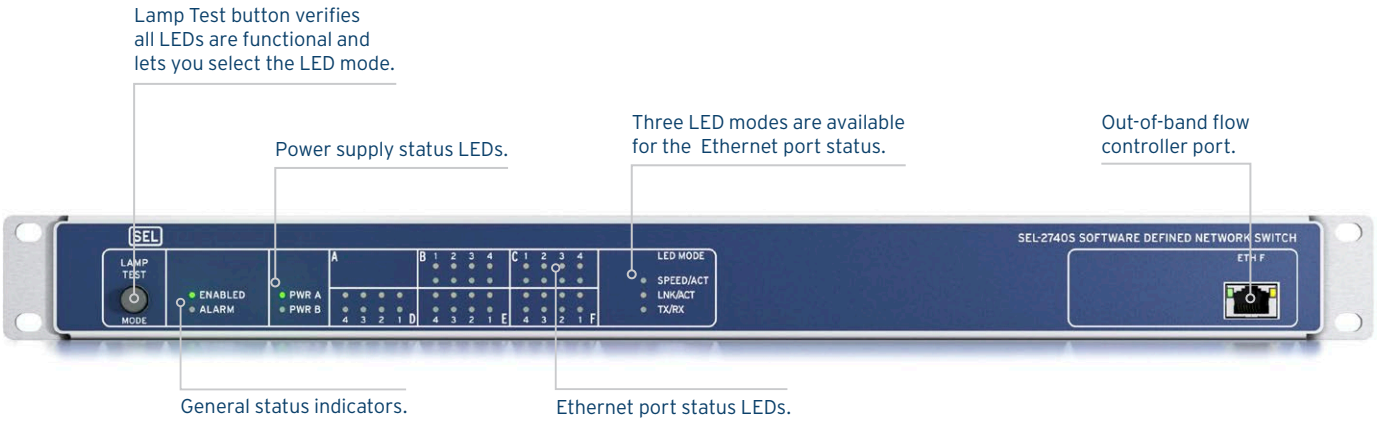
SEL-5056: $750 USD (free for up to 4 switches)

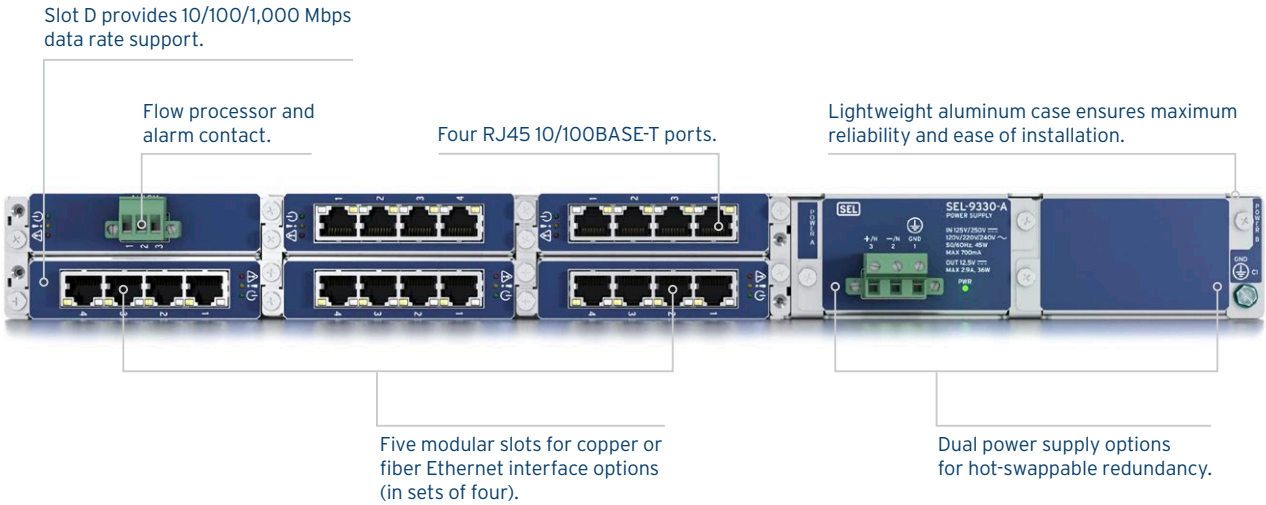
selinc.com/products/2740S

The SEL-2740S is the industry's first field-hardened software-defined networking (SDN) switch and is designed to improve substation LANs for mission-critical applications. By providing centralized traffic engineering, the SEL-2740S combined with the SEL-5056 Software-Defined Network Flow Controller give you path- and packet-level control of your communications flows. Together, they provide an innovative solution to enhance cybersecurity, failover performance, and IEC 61850 traffic management within the substation LAN. The SEL-2740S can also act as a transparent Precision Time Protocol (PTP) clock supporting the IEEE C37.238 power system profile to ensure submicrosecond time synchronization of end devices. It withstands harsh environments commonly found in the energy and utility sectors.

CENTRALIZED NETWORK VISIBILITY AND DIAGNOSTICS

Through the SEL-5056 Flow Controller, you can manage your entire network from a centralized point. The controller simplifies the design, implementation, and management of operational technology (OT) mission-critical networks. It enables you to monitor the status and health of the SEL-2740S network and manage changes without affecting existing services. You can graphically configure all flows and redundancies, simplifying settings and accelerating proactive traffic engineering.


Lamp Test button verifies all LEDs are functional and lets you select the LED mode.
Power supply status LEDs.
Three LED modes are available for the Ethernet port status.
Out-of-band flow controller port.
SEL
LAMP TEST
MODE
ENABLED
ALARM
PWR A
PWR B
A
B 1 2 3 4
C 1 2 3 4
4 3 2 1 D
4 3 2 1 E
4 3 2 1 F
LED MODE
SPEED/ACT
LNK/ACT
TX/RX
SEL-2740S SOFTWARE DEFINED NETWORK SWITCH
ETH F
General status indicators.
Ethernet port status LEDs.


Slot D provides 10/100/1,000 Mbps data rate support.
Flow processor and alarm contact.
Four RJ45 10/100BASE-T ports.
Lightweight aluminum case ensures maximum reliability and ease of installation.
SEL
SEL-9330-A
POWER SUPPLY
Five modular slots for copper or fiber Ethernet interface options (in sets of four).
Dual power supply options for hot-swappable redundancy.

SEL-2742S NEW

SOFTWARE-DEFINED NETWORK SWITCH

Starting Price

SEL-2742S: $2,000 USD

SEL-5056: $750 USD (free for up to 4 switches)

selinc.com/products/2742S

The SEL-2742S is a DIN-rail-mounted 12-port network switch for industrial environments. The SEL-2742S combines with the SEL-5056 Software-Defined Network Flow Controller to simplify network engineering and improve LAN cybersecurity with path- and packet-level control of communications flows.

The SEL-2742S can also serve as a transparent Precision Time Protocol (PTP) clock, supporting the IEEE C37.238 power system profile to ensure submicrosecond network time synchronization.

All SEL-2742S configurations come standard with two 10/100BASE-T ports, which support Power over Ethernet Plus (PoE+). The remaining ten ports are combinations of copper, single-mode fiber, and multimode fiber ports with up to four 1 Gbps ports.

The SEL-2742S is designed for harsh environments, meeting IEC 1613; IEC 61850-3; Class 1, Div. 2; and IEC 60255 standards. The SEL-2742S operates in −40° to +85°C (−40° to +185°F), and dual power supply connections provide connectivity to primary and backup power sources.

CENTRALIZED NETWORK VISIBILITY AND DIAGNOSTICS

Through the SEL-5056 Flow Controller, you can manage your entire network from a centralized point. The controller simplifies the design, implementation, and management of operational technology (OT) mission-critical networks. It enables you to monitor the status and health of the SEL-2742S network and manage changes without affecting existing services. You can graphically configure all flows and redundancies, simplifying settings and accelerating proactive traffic engineering.

SEL-3620/3622

ETHERNET SECURITY GATEWAY/SECURITY GATEWAY

Starting Price

SEL-3620: $2,800 USD

SEL-3622: $799 USD

selinc.com/products/3620 or selinc.com/products/3622

Select models typically ship in 2 days

The SEL-3620 and SEL-3622 each act as a router, VPN endpoint, and firewall device and can perform secure and proxy user access for serial- and Ethernet-based intelligent electronic devices (IEDs). They help create a user audit trail through strong, centralized, user-based authentication and authorization for modern and legacy IEDs. Each security gateway secures your control system communications with a stateful deny-by-default firewall, strong cryptographic protocols, and logs for system awareness. They also manage protected IED passwords, ensuring that passwords are changed regularly and conform to complexity rules. Device checkout and common, persistent passwords improve IED access.

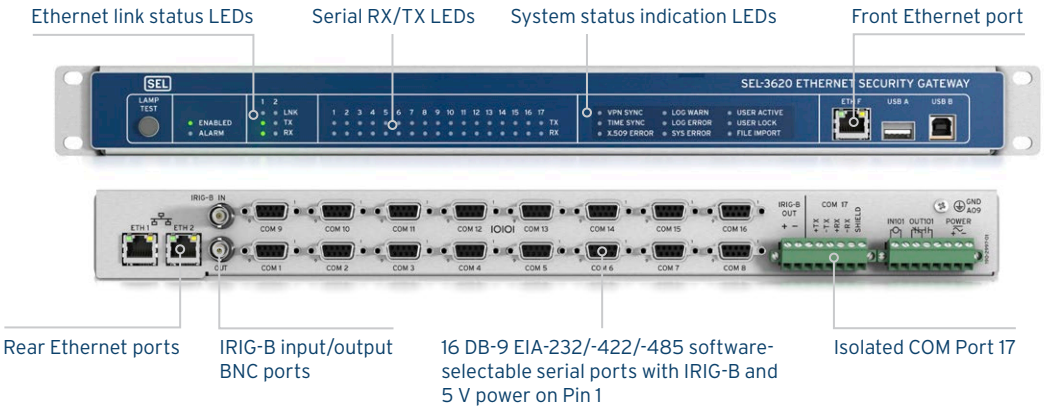
For enhanced security, the SEL-3620 and SEL-3622 help you protect critical cyber assets by employing strong multifactor authentication technologies, such as RSA SecurID, that use the Remote Authentication Dial-In User Service (RADIUS). The SEL security gateways resist known and unknown malware attacks with exe-GUARD® embedded antivirus technology. Powerful rootkit resistance, embedded Linux mandatory access controls, and process whitelisting help mitigate attacks against the gateways and eliminate costly patch management and antivirus signature updates.

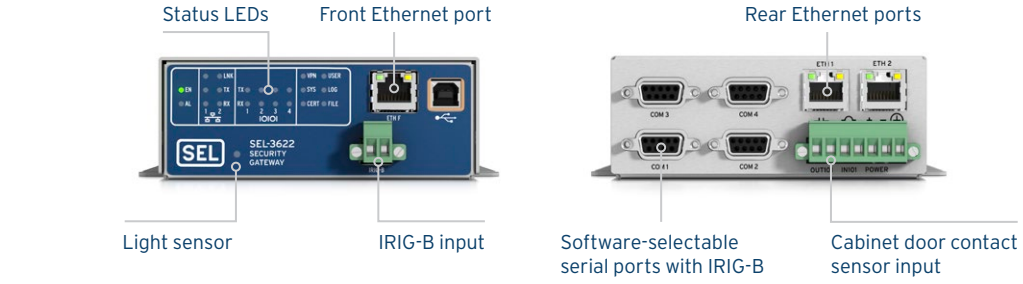
The SEL-3620 and SEL-3622 support NERC CIP compliance efforts without needing Technical Feasibility Exceptions (TFEs). They also support the SEL-5827 Virtual Connect Client and SEL-5828 Virtual Port Service Software. These free software applications make remote gateway ports available for existing software and terminal applications on your PC, including those using Modbus TCP/RTU.

The SEL-3620 has 16 serial ports with 5 V power on Pin 1 and comes in a rack-mount form factor. The SEL-3622 has 4 serial ports in a small form factor that is ideal for mounting in cabinets. It detects physical tampering with an onboard accelerometer, light sensor, and input contact sensor and alerts operators when Ethernet cables are connected or disconnected.

SEL designed and built the SEL-3620 and SEL-3622 in cooperation with the U.S. Department of Energy National SCADA Test Bed and the following companies:

- EnerNex Corporation
- Tennessee Valley Authority
- Sandia National Laboratories





SEL-2730M/2730U

24-PORT ETHERNET SWITCHES

Starting Price

SEL-2730M: $1,850 USD

SEL-2730U: $1,500 USD

selinc.com/products/2730M or selinc.com/products/2730U

Select models typically ship in 2 days

The SEL-2730M Managed 24-Port Ethernet Switch and SEL-2730U Unmanaged 24-Port Ethernet Switch support communications infrastructure for engineering access, SCADA, and real-time data communications while offering the same reliability found in SEL protective relays. Both switches are designed for the harsh conditions found in energy and industrial environments and meet or exceed the IEEE 1613 (Class 1), IEC 61850-3, and IEC 60255 industry standards for vibration, electrical surges, fast transients, extreme temperatures, and electrostatic discharge for communications devices in electrical substations.

The SEL-2730M is easy to use and administer, with a web management interface and advanced configuration options to meet your needs. The SEL-2730U is an unmanaged "no settings" switch with ports that automatically configure for crossover cables, speed, and half- or full-duplex operation.

SEL-3025

SERIAL SHIELD®

Starting Price

SEL-3025: $900 USD

PC Serial Security Kit: $400 USD

SEL-3045 Secure SCADA Card: $250 USD (included in kit)

selinc.com/products/3025

The SEL-3025 uses powerful AES 128-/256-bit and SHA-1/-256 key strengths to encrypt and authenticate serial and dial-up links at speeds up to 57,600 bps. The cryptographic module provides confidentiality and integrity for remote monitoring and interactive remote access while locking out hackers and other malicious intruders. With its remote management functionality and wide range of application support, the SEL-3025 is flexible and easy to use.

You can use the SEL-3025 with the PC Serial Security Kit to transform normal serial PC communications to cryptographically secure serial PC communications. Simply plug in the USB card dock and install the virtual port software to use a secured serial port with existing software and terminal applications.

SEL-3610

PORT SERVER

Starting Price
$1,800 USD

selinc.com/products/3610
Select models typically ship in 2 days

The SEL-3610 is an EIA-232, EIA-422, or EIA-485 serial-to-serial and Ethernet-to-serial cryptographic port server. It increases the number of available serial ports for communications processors and computers and allows serial products to communicate securely through Ethernet networks. The SEL-3610 tunnels serial data over an Ethernet connection using Secure Shell (SSH), Telnet, Modbus, or raw TCP or UDP encapsulation. The SEL-3610 provides highly flexible byte- or bit-based serial and Ethernet port mappings and can filter data based on which connections listen or transmit. You can configure the device to establish virtual bonds between one or more logical Ethernet ports and one or more physical serial ports. The SEL-3610 supports enhanced security, including user authentication through the Lightweight Directory Access Protocol (LDAP). It also supports multifactor authentication technologies, such as RSA SecurID, that use the Remote Authentication Dial-In User Service (RADIUS).

SEL-2725

FIVE-PORT ETHERNET SWITCH

Starting Price
$470 USD

selinc.com/products/2725
Select models typically ship in 2 days

The SEL-2725 is an unmanaged five-port switch and copper-to-fiber-optic media converter. With the SEL-2725, you can build reliable, safe Ethernet networks in electrical substations, plants, and other mission-critical sites. The SEL-2725 can connect to devices in the same cabinet using shielded twisted-pair Category 5 cable and communicate with the substation or LAN over a fiber-optic link. Mode conversions provide several key network benefits, including regenerating optical signals and extending transmission distances. You can increase the productive life of your existing cabling and active equipment without costly, across-the-board upgrades.

PORT OPTIONS

Copper		Fiber
3	and	2 multimode
3	and	2 single-mode
4	and	1 multimode
4	and	1 single-mode

WIRELESS COMMUNICATIONS OVERVIEW

SEL-3031

The SEL-3031 is a 900 MHz ISM serial data radio that supports point-to-point (P2P) and point-to-multipoint (P2MP) operational modes. In P2P mode, the SEL-3031 supports three serial data ports in one radio channel.

SEL-3061 NEW

The SEL-3061 provides remote access for devices using the public cellular radio network. It supports 4G LTE, 3G, and 2G cellular technologies.

SEL-2924

The portable SEL-2924 connects to an EIA-232 port on a relay, controller, or other device to enable secure Bluetooth® wireless communications from up to 10 m (32 ft) away.

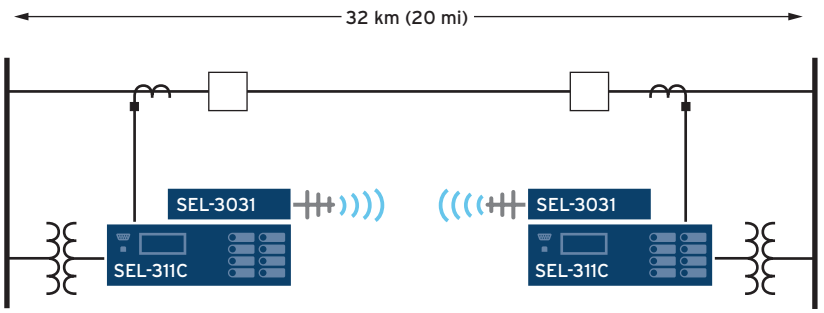
SEL-2925

The SEL-2925 connects to an EIA-232 serial port in a control cabinet or panel to enable Bluetooth wireless communications from up to 100 m (328 ft) away.

	SEL-3031	SEL-3061	SEL-2924	SEL-2925
APPLICATIONS				
Wireless Communications for SCADA	•	•		•
High-Speed Teleprotection	•			
Distribution Automation	•	•		
Wireless Communications for Synchrophasor Data	•	•		
Substation-to-Substation Communications Link		•		
Anti-Island Detection	•	•		
Wireless Communications for Distributed Generation	•	•		
Permanent Wireless Cable Replacement	•	•		•
Temporary Wireless Cable Replacement			•	
Remote Engineering Access	•	•		
Short-Range Engineering Access	•	•	•	•
LAN Extension		•		
Wireless Backhaul Communications for Fault and Load Transmitters		•		
FEATURES				
915 MHz ISM Band (License-Free)	•			
2.4 GHz ISM Band (License-Free)			•	•
Serial Communication	•	•	•	•
Ethernet Communication		•		
Low Latency for Teleprotection	•			
Compatible With SEL Mirrored Bits® Communications	•			
Compatible With Modbus	•	•		
Compatible With DNP3 and Typical Byte-Oriented Protocols	•	•	•	•
Encryption	ƒ	•	•	•
Point-to-Multipoint Capability	•			
Cellular Capability		•		
EIA-232 Port (Quantity)	3	1	1	1
Wired EIA-485 Port	+			
High Maximum Throughput (1 Mbps or Greater)		•		
Device Status LEDs	•	•	•	•
Visible Link Quality Indicator		•		
SETUP METHOD				
USB Port	•			
Secure Web Interface Via Ethernet Port		•		
Control (DIP) Switches			•	•
Wireless Configuration	•	•	•	•
Simple Network Management Protocol (SNMP)		•		

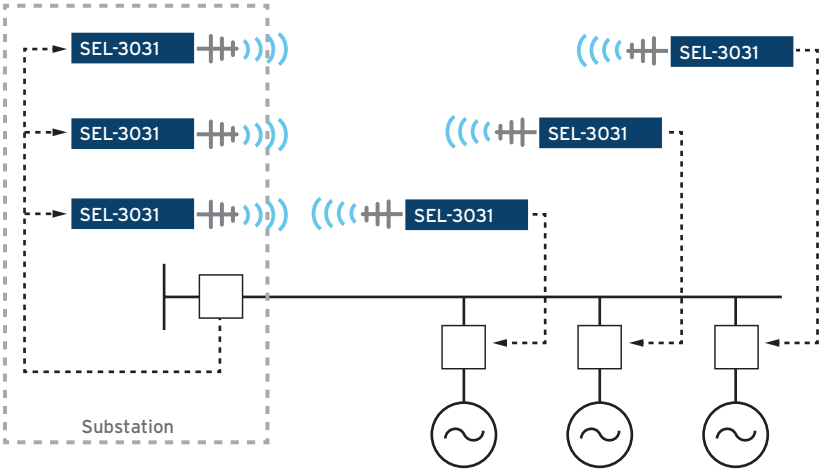
• Standard feature + Model option ƒ With SEL-3044 Encryption Card option

WIRELESS COMMUNICATIONS APPLICATIONS



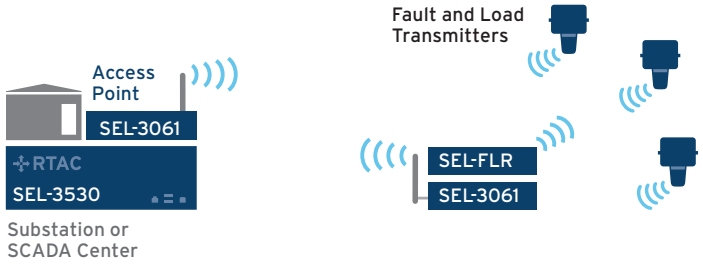
ELECTRICAL TRANSMISSION LINES

Apply SEL-3031 Serial Radio Transceivers for communications-assisted teleprotection instead of local step-distance protection to accelerate the operation time for Zone 2 faults from 20—40 electrical cycles to 2—4 cycles. You can transfer control commands with a typical 5.5 ms latency via SEL Mirrored Bits® communications. The remaining serial channels can provide engineering access and primary or backup SCADA communications.



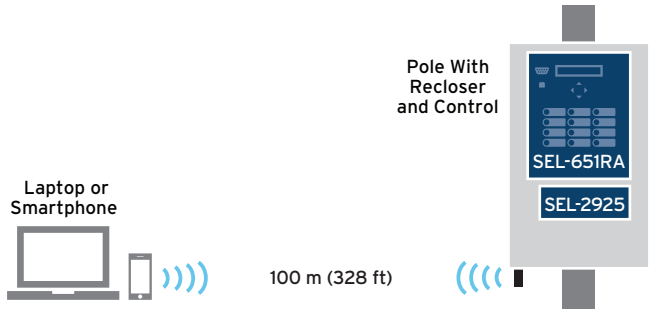
DISTRIBUTED GENERATION

A distributed generation source needs a high-speed, low-latency communications link between each distributed generator and the substation to feed power to the electric utility. An SEL-3031 Serial Radio Transceiver communications link allows the control center to monitor each distributed generation site, read meter information, and, most importantly, automatically disconnect the distributed generation site if system issues arise. High-speed radio communications facilitate applications such as anti-island detection and power curtailment control. The low price and installation cost of radios make them an attractive choice for these applications.



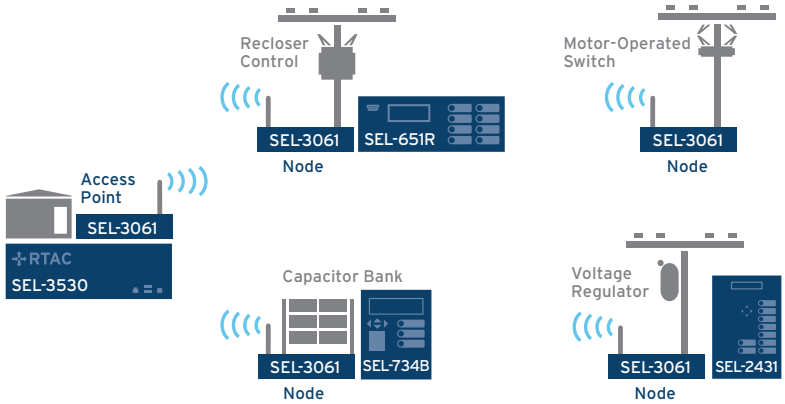
BACKHAUL FOR FAULT AND LOAD TRANSMITTER AND RECEIVER SYSTEMS

The SEL-FLR Fault and Load Receiver collects fault and load data from SEL-FLT Fault and Load Transmitters. With the SEL-3061 Cellular Router, you can backhaul that information to a real-time automation controller (RTAC) in the substation or to a centralized location.



WIRELESS ENGINEERING ACCESS

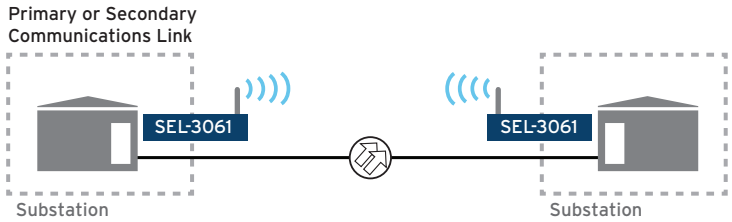
Provide local engineering access with an SEL-2925 BLUETOOTH® Serial Adapter. This adapter lets you avoid opening the door and exposing the recloser control to precipitation or windblown contaminants. With the SEL-2925, you can access the recloser control from up to 100 m (328 ft) away to avoid hazards to personnel.



DISTRIBUTION NETWORK AUTOMATION

Distribution System Communications

Provide communications for distribution automation with the SEL-3061. Cellular links are a cost-effective solution for collecting SCADA information from field devices and for engineering access to devices. The SEL-3061 works wherever you have public cellular coverage.



Communications to Substations

Use the SEL-3061 to communicate with substation equipment over secure cellular networks. This can be the primary communications link, or it can be a redundant link for a fiber cable.

SEL-3031
SERIAL RADIO TRANSCEIVER

Starting Price
$973 USD

selinc.com/products/3031

The SEL-3031 is a 915 MHz ISM serial data radio that supports point-to-point (P2P) and point-to-multipoint (P2MP) operational modes. In P2P mode, the SEL-3031 supports three serial data ports in one radio channel. The ports are completely independent and support a mix of protocols, including DNP3, Modbus, MIRRORED BITS® communications, SEL Fast Message, plain ASCII, and more. In P2MP mode, a one-channel master radio communicates with multiple remote radios for SCADA or other data-gathering applications. SEL Hop-Sync™ technology optimizes co-located radios applied as multiple point-to-point links or as active repeaters. The SEL-3031 is a low-power device using less than 5 W in the wall-mount version, which allows you to incorporate it into recloser controls, such as the SEL-651R Advanced Recloser Control. A 1 RU rack-mount version is also available.

SEL-3061 NEW
CELLULAR ROUTER

Starting Price
$750 USD

selinc.com/products/3061

The SEL-3061 is a secure router for critical applications. For electric utilities, the SEL-3061 provides connectivity to recloser controls, motor-operated switches, capacitor banks, voltage regulators, substations, and much more. The combination of serial and Ethernet ports provides application flexibility, and using public networks with secure tunneling makes installation easy without sacrificing security.

SEL-2924

PORTABLE BLUETOOTH® SERIAL ADAPTER

Starting Price
$129 USD

selinc.com/products/2924

The SEL-2924 connects to an EIA-232 port on a relay, controller, or other device as a portable solution for wireless communication from a convenient, safe location. You can use the built-in Bluetooth wireless capability of a laptop, smartphone, or other device to enable a secure wireless link from up to 10 m (32 ft) away. The adapter comes with batteries and a USB Standard-A to Micro-B cable for charging.

SEL-2925

BLUETOOTH SERIAL ADAPTER

Starting Price
$129 USD

selinc.com/products/2925

The SEL-2925 connects to an EIA-232 port on a relay, controller, or other device and is useful for permanent installation to avoid entering hazardous areas. It transmits data at up to 115,200 bps to distances of 100 m (328 ft) in typical applications with a line-of-sight communications path. For even greater distances, you can use directional gain antennas. The adapter receives power via the included USB Standard-A to Micro-B cable. Optional accessories include a worldwide ac power supply or a USB cable with plain wires to connect the SEL-2925 to a 5 Vdc source.

PRECISE TIME OVERVIEW

SEL-2488

The SEL-2488 receives GNSS time signals and distributes precise time via multiple output protocols, including IRIG-B, PTP, and NTP, with ±40 ns accuracy.

SEL-2407®

The SEL-2407 provides a time display and high-accuracy timing (±100 ns).

SEL-2401

The SEL-2401 is a satellite clock with high-accuracy timing (±100 ns) for compact spaces.

SEL-2404

The SEL-2404 is a high-accuracy (±100 ns) satellite clock with a highly visible time display.

SEL-3401

The SEL-3401 provides a highly visible time display for use anywhere there are time-critical functions set by IRIG-B synchronization signals.

SEL-9929

The SEL-9929 Kit includes a satellite-synchronized clock, a large digital clock display, and all accessories to work right out of the box.

SEL-3400

The SEL-3400 verifies time signals and distributes precise time to 240 devices.

SEL-3405

SEL-3405 Transceivers send delay-compensated demodulated IRIG-B signals up to 4 km (2.5 mi) over fiber-optic cable.

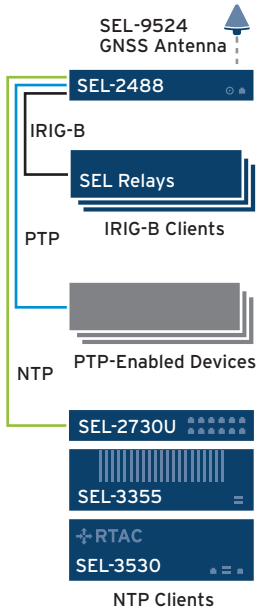
SEL-9524

The SEL-9524 is a rugged and reliable antenna for GNSS devices in critical infrastructure applications.

	SEL-2401	SEL-2404	SEL-2407®	SEL-3400	SEL-3401	SEL ICON®	SEL-2488
APPLICATIONS							
Time Source for Substation	•	•	•	•		•	•
Time Source for Industrial Applications	•	•	•	•		•	•
Time Source for Phasor Measurement Unit (IEEE C37.118.1-2011 Synchrophasors)	•	•	•	•		•	•
Time Source for Recloser	•		•				
Time Source for Line Current Differential Protection	•	•	•	•		•	•
Time Source for Traveling-Wave Fault Location	•	•	•	•		•	•
Time-Synchronized Event Reporting	•	•	•	•		•	•
Long-Distance Viewing, 61 m (200 ft)		•			•		
TIME SOURCES AND TIME DISTRIBUTION							
Demodulated IRIG-B Outputs (Quantity)	1	4	6	12	4+	4	up to 8
Modulated IRIG-B Outputs (Quantity)			1				up to 4
GPS Satellite Tracking	•	•	•			•	•
GLONASS Satellite Tracking (Reference Only)							•
Demodulated IRIG-B Input				•	•	•	
Synchronized Pulse Output	•	•	•				•
Network Time Protocol (NTP) Server	f		f				•
IEEE 1588 Precision Time Protocol (PTP) (With IEEE C37.238 Power System Profile)						•	+
IEEE 1588 PTP Slave							
PTP-to-IRIG-B Converter							
Satellite Signal Verification							•
FEATURES							
76.2 mm (3.0 in) LED Display		•			•		
14 mm (0.56 in) LED Display			•	•			•
Rack-Mount Hardware	•	•	•	•	•	•	•
Panel-Mount or Wall-Mount Hardware	•	•	•	•	•	•	
PCIe Integration Into a Computer							
Universal Power Supply			•	•		•	•
Dual, Redundant, Hot-Swappable Power Supplies						•	•
Power Over Ethernet (PoE) Power Sourcing Equipment (PSE)						•	
Secure Web Interface for Configuration							•
Serial Ports for Configuration	•	•	•				
User-Based Accounts						•	•
TCXO Holdover	•	•	•			•	•
OCXO Holdover							+
Time-Code Cable Delay Compensation				•		•	•
IEEE C37.90 and IEC 60255 Surge and Environmental Standards Compliance	•	•	•	•	•	•	•
ACCURACY							
Average Accuracy (ns)	±100	±100	±100				±40
Peak Accuracy (ns)	±500	±500	±500			±1,000	±100

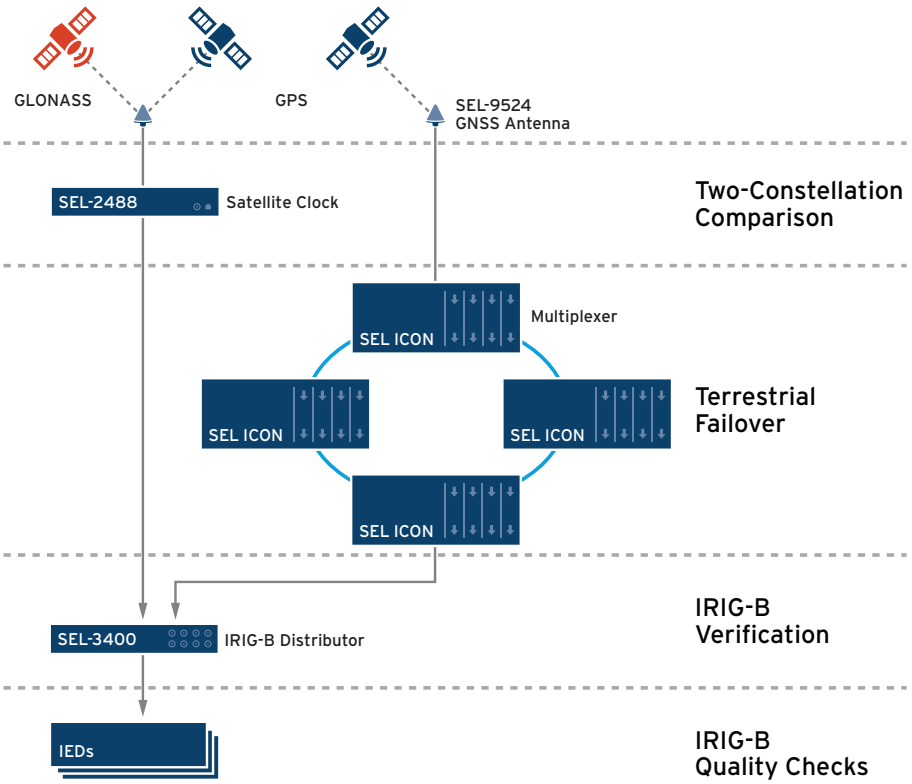
• Standard feature + Model option/accessory f With SEL-5860 Time Service Software

PRECISE TIME APPLICATIONS



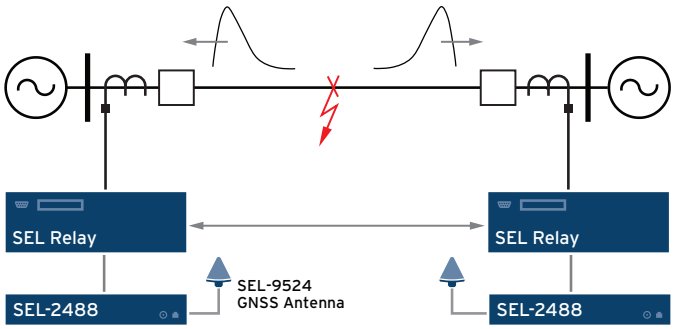
TIME SYNCHRONIZATION IN THE SUBSTATION

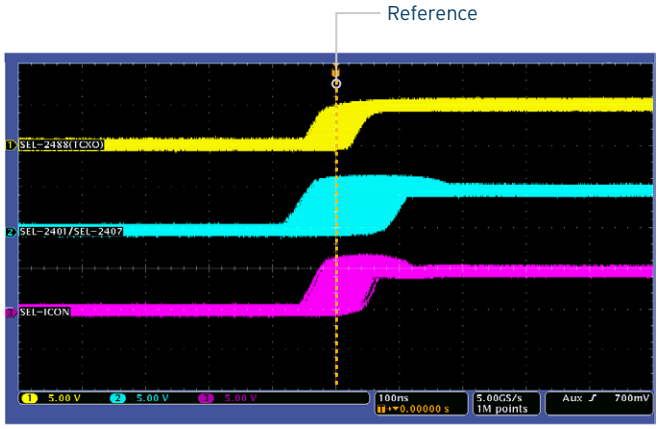
Use the SEL-2488 Satellite-Synchronized Network Clock's demodulated IRIG-B time outputs in electric utility applications to synchronize relays, phasor measurement units, and other IEDs to within ±40 ns average accuracy of UTC. You can configure modulated IRIG-B for as many as four SEL-2488 BNC outputs to synchronize legacy devices. Using the DB-9 port with SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceivers lets you send IRIG-B time code long distances over fiber-optic cable. The SEL-2488 Ethernet ports can use the Network Time Protocol (NTP) to distribute time to devices on the substation LAN, such as servers, computers, and other devices that set their time through NTP or the Simple Network Time Protocol (SNTP). With the Precision Time Protocol (PTP) option, the SEL-2488 acts as a PTP grandmaster clock, supporting both the default PTP profile (IEEE 1588-2008) and the power system profile (IEEE C27.238). The SEL-2488 can serve NTP or PTP to four independent networks.



LAYERS OF PROTECTION FOR TIME SYNCHRONIZATION

Configure your equipment to detect and respond to signal loss or degradation. Precise time is critical to the optimal operation of your system. You can combine SEL precise-time products into a multilayered system to ensure highly reliable time synchronization, from satellite signal acquisition through time distribution to end devices.



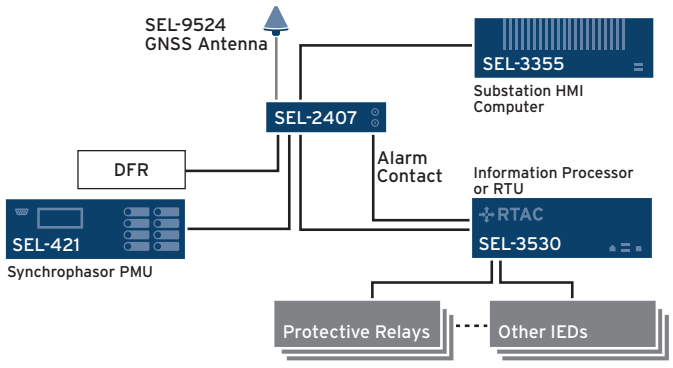


Dotted line represents 100 ns increments.

HIGH-ACCURACY TIME SYNCHRONIZATION FOR ADVANCED RELAYING APPLICATIONS

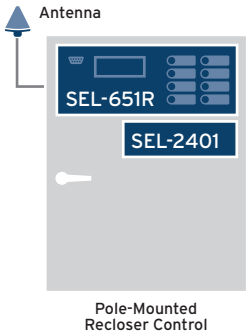
Take advantage of the high accuracy of SEL clocks to perform time-dependent relaying applications. The SEL time-based system for line current differential protection in SEL-400 series relays requires submicrosecond accuracy in order to operate properly. For traveling-wave fault locating in the SEL-411L Advanced Line Differential Protection, Automation, and Control System, the performance of the application is tied directly to the performance of the time source. SEL clocks have the accuracy required to meet these stringent requirements. With tight initial accuracy and excellent holdover performance, clocks like the SEL-2488 exceed timing needs.

The oscilloscope plot shows the accuracy of SEL products. The offset from zero represents the average accuracy of the clock, and the width of the signal represents the variance in the accuracy; i.e., jitter.



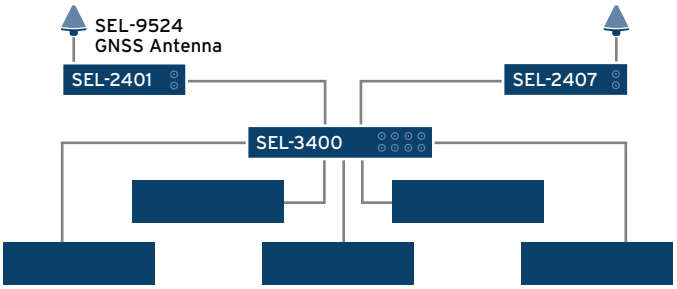
TIME SYNCHRONIZATION WITH THE SEL-2407®

Apply the SEL-2407 Satellite-Synchronized Clock in a substation to synchronize relays, phasor measurement units (PMUs), Sequential Events Recorders, information processors, and other devices. You can synchronize up to 120 devices via the six demodulated IRIG-B output ports. The SEL-2407 also has an additional port for distributing modulated IRIG-B.



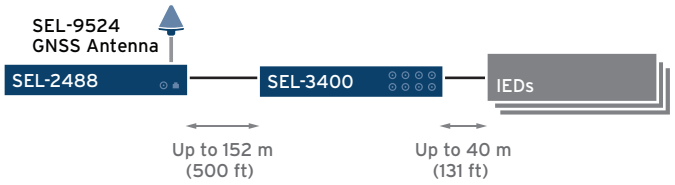
SYNCHROPHASOR CONTROL AND EVENT REPORTING WITH THE SEL-2401

Install the SEL-2401 Satellite-Synchronized Clock in recloser control enclosures for synchrophasor control and high-accuracy event correlation and reporting. The SEL-2401 is a compact, low-cost, low-power clock that is reliable in harsh environments.



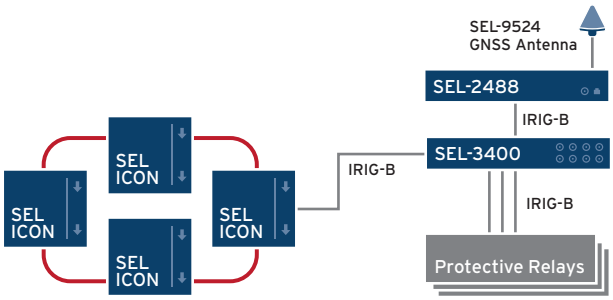
TIME SOURCE VALIDATION

Connect the SEL-3400 IRIG-B Distribution Module to two IRIG-B inputs. You can configure those inputs for redundancy to maintain accurate time in the event of time source degradation or failure.



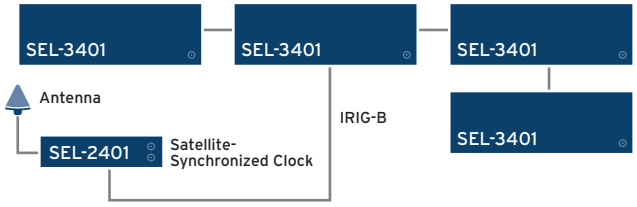
INCREASED DISTANCE FOR IRIG-B CABLING

Synchronize devices using demodulated IRIG-B by applying an SEL-3400 to extend the distance between the clock and the devices. This is useful in large facilities where you want to avoid using multiple GPS clocks. The SEL-3400 compensates for its input-to-output latency plus the latencies of connected cables.



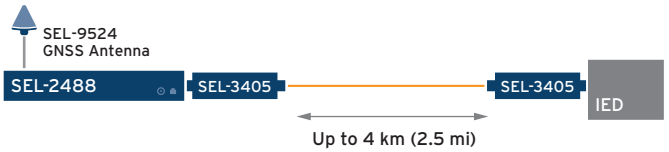
PRECISE TIME DISTRIBUTION WITH THE ICON® AND SEL-3400

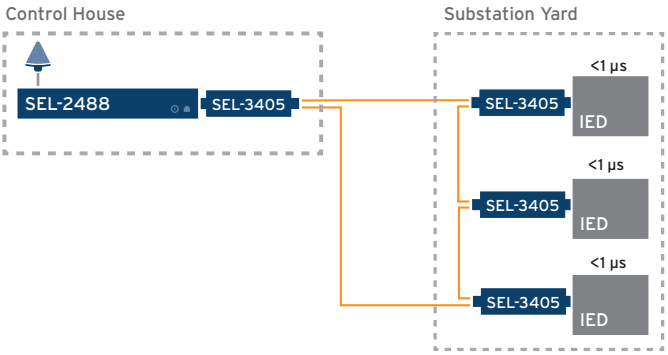
Distribute precise time throughout a WAN with the SEL ICON Integrated Communications Optical Network, and use the SEL-3400 for convenient distribution within racks or panels. The SEL-3400 receives a precise time signal from an ICON network or other precise time source and distributes time to up to 240 devices via 12 demodulated IRIG-B outputs.



TIME DISPLAY AND COMMUNICATION WITH THE SEL-3401

Use SEL-3401 Digital Clocks to display time in control rooms, substations, and industrial and manufacturing environments. Optional IRIG-B ports let you distribute time signals to additional clocks and devices.





TIME SYNCHRONIZATION TO REMOTE DEVICES

Use the SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceiver to send IRIG-B across distances where coaxial cabling is not feasible. Connecting an SEL-3405 at both the clock and the end device enables the device to receive delay-compensated IRIG-B, with no settings to adjust. The SEL-3405 automatically adjusts for the delay that occurs as the signal moves through the multimode fiber. With the SEL-3405, you can send time between individual devices or set up a ring network to provide <1 µs accurate IRIG-B signals to multiple devices simultaneously.

SEL-2488

SATELLITE-SYNCHRONIZED NETWORK CLOCK

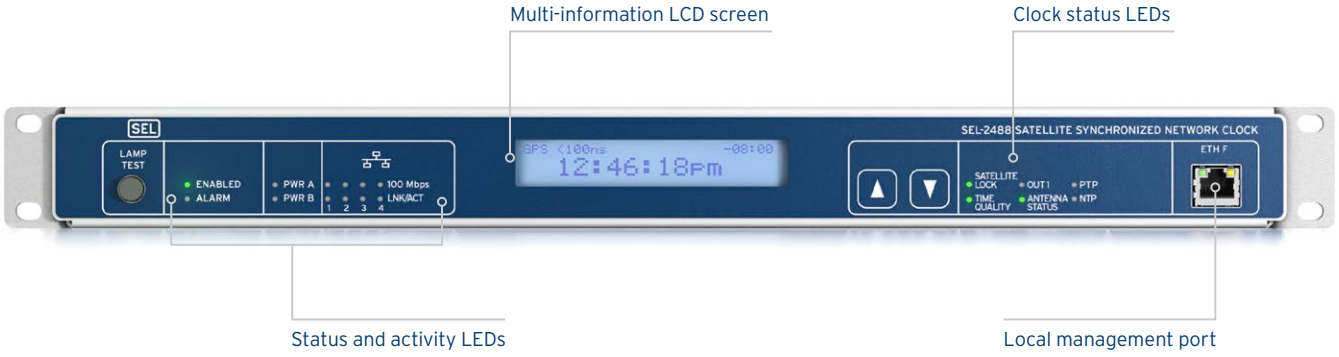
Starting Price

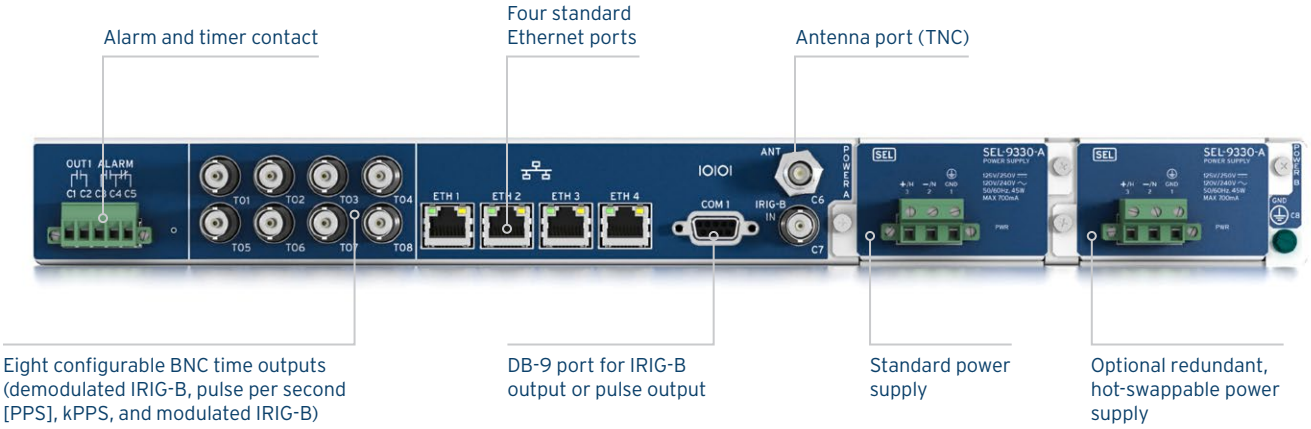
$2,450 USD

selinc.com/products/2488

Select models typically ship in 2 days

The SEL-2488 receives GNSS time signals and distributes precise time via multiple output protocols, including IRIG-B and the Network Time Protocol (NTP). The SEL-2488 provides Parallel Redundancy Protocol (PRP) support as a dual attached node (DAN) device for NTP time distribution. When installed with a dual-constellation antenna, the SEL-2488 offers satellite signal verification by using signals from two satellite constellations to validate GNSS time signals, providing a layer of protection against spoofing attacks. With an optional upgrade, the SEL-2488 can serve as a Precision Time Protocol (PTP) grandmaster clock, as defined by IEEE 1588. The advanced capabilities of the SEL-2488 make it well-suited for demanding applications, such as synchrophasors, and for substations with multiple time synchronization requirements.





SEL-2407®

SATELLITE-SYNCHRONIZED CLOCK

Starting Price
$1,200 USD

selinc.com/products/2407

Select models typically ship in 2 days

The SEL-2407 is a reliable, durable clock that offers a time display and high-accuracy, satellite-synchronized timing. The SEL-2407 provides ±100 ns average timing accuracy (±500 ns peak) for IEEE C37.118 synchrophasor control function extensions and event correlation and reporting. IEEE C37.90 and IEC 60255 design standards ensure accurate timing over a temperature range of −40° to +80°C (−40° to +176°F) and in the presence of electrical surges and power supply variations. One modulated and six demodulated IRIG-B outputs let you synchronize relays directly or through an SEL information processor.

SEL-2401

SATELLITE-SYNCHRONIZED CLOCK

Starting Price
$498 USD

selinc.com/products/2401

Select models typically ship in 2 days

The SEL-2401 is a compact, precise-time device that offers ±100 ns timing accuracy for applications such as IEEE C37.118 synchrophasor control function extensions and event correlation and reporting. The SEL-2401 provides accurate operation from −40° to +80°C (−40° to +176°F) and is compliant with IEEE C37.90 and IEC 60255. You can synchronize up to 20 devices from one IRIG-B output. The SEL-2401 is FCC Part 15, Class A emissions-certified for industrial sites.

SEL-2404
SATELLITE-SYNCHRONIZED CLOCK

Starting Price
$1,200 USD

selinc.com/products/2404

The SEL-2404 is a reliable, durable clock with a 76 mm (3 in) LED time display. Four demodulated IRIG-B outputs with an average accuracy of ±100 ns (±500 ns peak) meet requirements for existing and future timing applications.

SEL-3401
DIGITAL CLOCK

Starting Price
$392 USD

selinc.com/products/3401

The SEL-3401 provides a highly visible time display for use anywhere there are time-critical functions. Easy-to-read 76 mm (3 in) LED digits are visible up to 60 m (200 ft) away. The SEL-3401 is set by IRIG-B signals and includes up to four IRIG-B outputs to send time signals to other SEL digital clocks or devices.

SEL-9929
SATELLITE-SYNCHRONIZED CLOCK DISPLAY KIT

Starting Price
$1,051 USD

selinc.com/products/9929

This kit includes a satellite-synchronized clock, a large digital clock display, and all accessories to work right out of the box. The clock supplies accurate time to synchronize up to 15 display clocks. The clock display has high-visibility LED digits that can be read up to 60 m (200 ft) away. The clock and display are designed to work in harsh environments with a wide operating temperature.

SEL-3400
IRIG-B DISTRIBUTION MODULE

Starting Price
$700 USD

selinc.com/products/3400

The SEL-3400 is a cost-effective, reliable, and precise way to distribute demodulated IRIG-B time information. With 12 IRIG-B distribution ports and a bright display, the SEL-3400 is ideal for time distribution in panels. When using two time inputs, the SEL-3400 automatically selects the best source for maintaining time. It exceeds IEEE C37.90 and IEC 60255 protective relay standards and accurately operates from −40° to +85°C (−40° to +185°F).

SEL-3405

HIGH-ACCURACY IRIG-B FIBER-OPTIC TRANSCEIVER

Starting Price
$191 USD

selinc.com/products/3405

Select models typically ship in 2 days

SEL-3405 Transceivers provide a multimode fiber link between two DB-9 serial ports, sending delay-compensated demodulated IRIG-B up to 4 km (2.5 mi) over a fiber-optic cable. The transceivers require no settings to accurately calculate the delay compensation.

SEL-9524

GNSS ANTENNA

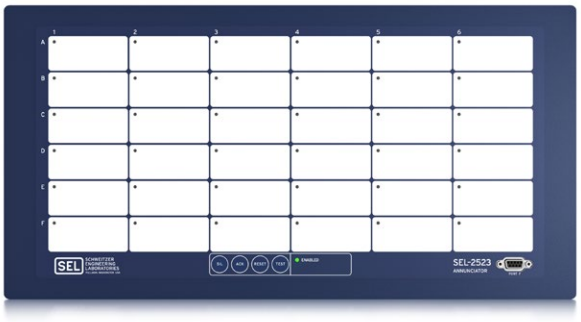
Starting Price
SEL-9524A: $250 USD SEL-9524B: $300 USD

selinc.com/products/9524

Select models typically ship in 2 days

The SEL-9524 is a rugged and reliable antenna designed for GNSS devices in critical infrastructure applications. The antenna is IP68-rated, making it suitable for harsh environments. Industry-leading surge immunity allows this antenna to provide superior performance in the presence of lightning and other surge events. The SEL-9524A receives GPS signals, and the SEL-9524B receives both GPS and GLONASS signals.

ANNUNCIATION AND NOTIFICATION OVERVIEW



SEL-2523

Starting Price
$3,700 USD

selinc.com/products/2523

Provide local and remote notifications with the SEL-2523 Annunciator Panel, which includes programmable logic and up to four communications ports.

SEL-2522

Starting Price
$2,100 USD

selinc.com/products/2522

Apply the SEL-2522 Alarm Panel with up to 36 inputs to easily view the status of alarms and operating events.

SEL-2533

Starting Price
$1,500 USD

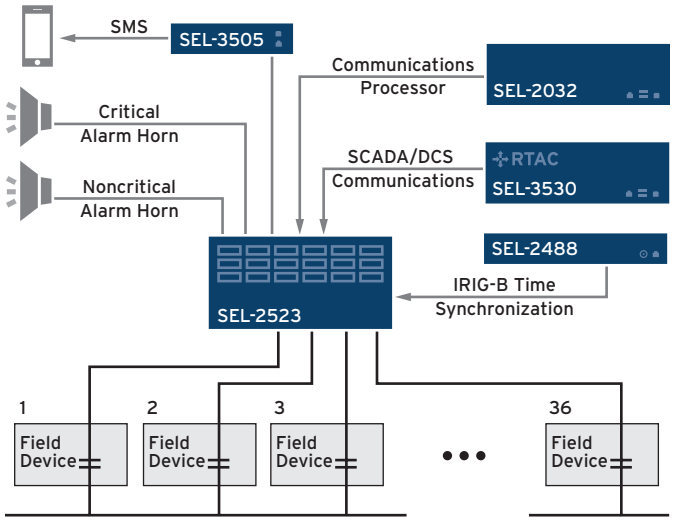
selinc.com/products/2533

Use the compact, ten-window SEL-2533 Annunciator to provide local and remote annunciation.

	SEL-2522	SEL-2523	SEL-2533
APPLICATIONS			
Local Visual Indication	•	•	•
Remote Visual Indication		•	•
Local Audible Indication	•	•	•
Remote Audible Indication	•	•	•
Telephone Dial-Out Messages		•	•
Local SELOGIC® Control Equations and Time Tagging		•	•
MOUNTING AND LABELING			
Rack Mount	+	+	
Panel Mount	+	+	•
User-Defined Slide-In Labels	•	•	•
INPUTS, OUTPUTS, AND HMI			
General-Purpose Digital Inputs	36	42	14+
Acknowledge, Reset, Test Digital Inputs	3	6	4+
General-Purpose Digital Outputs	1	11	14+
Alarm Digital Output	1	1	1
General Display LEDs/Windows	36	36	10
Enabled LED	1	1	1
Pushbuttons	3	4	4
Base Serial Ports		3	3
Optional Additional EIA-232 or EIA-485 Port		1	1
IRIG-B Time Input		1	1
ISA Annunciation Alarm Sequence Choices	2	8	8
SERIAL COMMUNICATIONS PROTOCOLS			
SEL MIRRORED BITS® Communications		•	•
SEL Fast Messages		•	•
Send SEL Messenger Points		•	•
Modbus RTU		•	•
DNP3 Level 2 Outstation		+	+

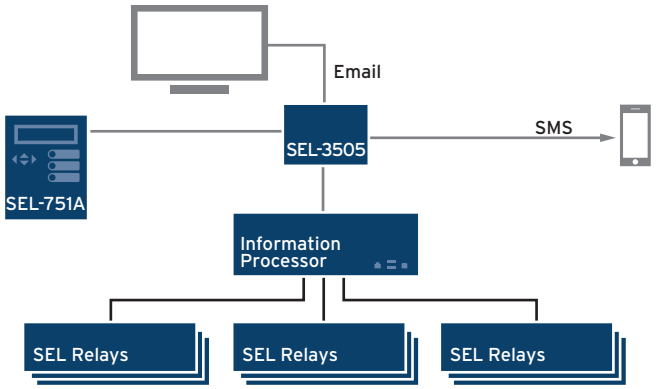
• Standard feature + Model option

ANNUNCIATION AND NOTIFICATION APPLICATIONS



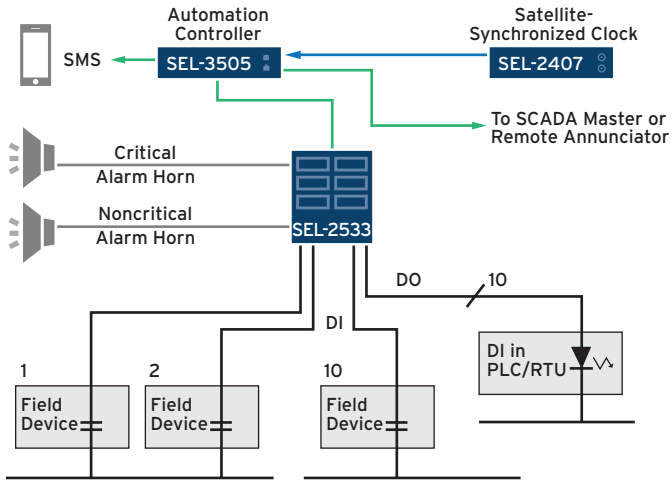
SYSTEM MONITORING

Receive station equipment status information through hardwired contacts or communications devices to provide a single-point alarm station. SEL annunciators can monitor equipment, report the status of any equipment that has failed, and notify local and remote personnel of current conditions.



REMOTE ALARM NOTIFICATION

Transmit important system data and alarm information by phone to on-call operators. SEL annunciators enable on-call responses to critical alarms for municipal and industrial sites.



AUTOMATED ALARMING

Eliminate control hardwiring with 40 remote control bits. With SELOGIC® control equations, you can program remote bits into custom control schemes, such as SCADA-type control operations (i.e., alarm triggers), acknowledgment, and device status indication.

REMOTE I/O OVERVIEW

SEL-2505/2506/2507

Starting Price
$525 USD

selinc.com/products/2505
selinc.com/products/2506
selinc.com/products/2507
Select models typically ship in 2 days

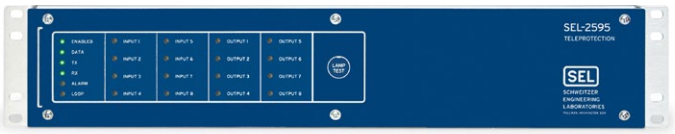
Reduce operating time, add self-wiring, and simplify wiring for auxiliary inputs and outputs with the SEL-2505 Remote I/O Module, SEL-2506 Rack-Mount Remote I/O Module, and SEL-2507 High-Speed Remote I/O Module.

SEL-2515/2516

Starting Price
$525 USD

selinc.com/products/2515
selinc.com/products/2516

Extend contact I/O for SEL information processors with the SEL-2515 Remote I/O Module and the SEL-2516 Rack-Mount Remote I/O Module. They monitor the status of external contacts transmitted via SEL Fast Meter messages to a communications processor and can control contact outputs using SEL Fast Operate commands.



SEL-2595

Starting Price
$1,680 USD

selinc.com/products/2595

Use the SEL-2595 Teleprotection Terminal to securely transfer teleprotection signals through a high-speed IEEE C37.94 optical-fiber interface.

SEL-3094

Starting Price
$685 USD

selinc.com/products/3094

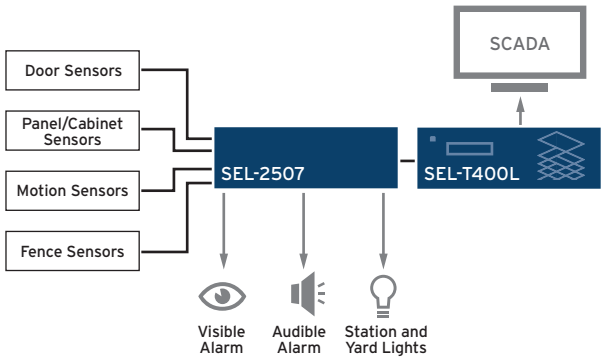
Implement the SEL-3094 Interface Converter to convert electrical teleprotection interfaces to the IEEE C37.94 optical standard for improved safety, signal integrity, and communication over longer distances. Connecting an SEL-3094 to an ITU-T G.703, EIA-422, EIA-485, or EIA-232 device lets you use up to 2 km (1.2 mi) of optical fiber to link to an IEEE C37.94 multiplexer.

	SEL-2505	SEL-2506	SEL-2507	SEL-2515	SEL-2516	SEL-2595
APPLICATIONS						
Save Wiring Via I/O Multiplexing	•	•	•	•	•	•
I/O for SEL Relays/SEL-3530/SEL-2100	•[1]	•[1]	•[1]			
I/O for Information Processors				•[1]	•[1]	
Transfer I/O to SEL-2505/2506/2507	•	•	•			
Transfer I/O to SEL-2507/T400L With Millisecond Mirrored Bits® Communications			•			
Transfer I/O to SEL-2594/2595						•
Teleprotection	•	•	•			•
Improve Safety With Optical Fiber	•	•	•	•	•	•
NUMBER OF I/O CHANNELS						
Digital Inputs (DI) Base	8	8	8	8	8	8
DI Maximum	8	8	8	8	8	8
Digital Outputs (DO) Base	8	8	8	8	8	8
DO Maximum	8	8	8	8	8	8
SERIAL COMMUNICATIONS PROTOCOLS						
SEL Mirrored Bits Communications	•	•	•			
SEL Fast Messages				•	•	
IEEE C37.94						•

• Standard feature

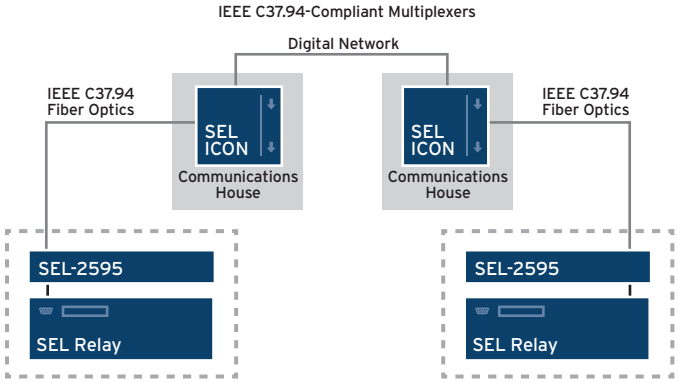
[1]With compatible SEL fiber-optic transceiver or interface option at relay or processor

REMOTE I/O APPLICATIONS



SUBSTATION PHYSICAL SECURITY

Enhance substation security monitoring and protection with motion detectors, touch sensors, visible and audible alarms, and lighting technology. You can send substation security information to a SCADA system with Modbus or DNP3 over serial or Ethernet connections.



TELEPROTECTION

Send and receive transfer trip commands between substations with high-speed teleprotection equipment and protective relays.

TRANSCEIVERS AND ADAPTERS OVERVIEW

SEL-2800/2815

Starting Price
$102 USD

selinc.com/products/2800
selinc.com/products/2815
Select models typically ship in 2 days

Improve safety, signal integrity, and reliability of EIA-232 communications by using multimode SEL-2800/2815 Fiber-Optic Transceivers instead of wire.

SEL-2810/2812/2814

Starting Price
$132 USD

selinc.com/products/2810
selinc.com/products/2812
selinc.com/products/2814
Select models typically ship in 2 days

Use EIA-232 multimode fiber-optic transceivers instead of wire. The SEL-2810 and SEL-2812 support IRIG-B time signals, while the SEL-2814 works with hardware flow control signals.

SEL-2829/2830/2831

Starting Price
$375 USD

selinc.com/products/2829
selinc.com/products/2830
selinc.com/products/2831
Select models typically ship in 2 days

Apply the SEL-2829/2830/2831 Single-Mode Fiber-Optic Transceiver/Modem to use two optical fibers instead of wire to transfer bidirectional serial data.

SEL-2820/2824

Starting Price
$250 USD

selinc.com/products/2820
selinc.com/products/2824
Select models typically ship in 2 days

Apply the SEL-2820/2824 Multimode Fiber-Optic Transceivers to safely add isolated segments to multidrop and point-to-point EIA-485 networks.

SEL-2890

Starting Price
$200 USD

selinc.com/products/2890
Select models typically ship in 2 days

Add Ethernet connectivity to an SEL device using its EIA-232 serial port with the SEL-2890 Ethernet Transceiver.

SEL-9192

Starting Price
$250 USD

selinc.com/products/9192

Connect remote terminal units (RTUs), communications processors, and other equipment with the SEL-9192 Utility-Grade USB Modem for dial-up or dial-out engineering access.

SEL-9220

Starting Price
$320 USD

selinc.com/products/9220

Convert the EIA-485 port of an SEL-300 series relay to a point-to-point fiber-optic port with the SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays.

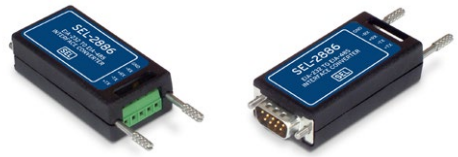
SEL-2894

Starting Price
$350 USD

selinc.com/products/2894

Select models typically ship in 2 days

Apply the SEL-2894 Interface Converter to transfer SEL MIRRORED BITS® communications via an IEEE C37.94 fiber-optic link through a communications multiplexer.



SEL-2886

Starting Price
$130 USD

selinc.com/products/2886

Select models typically ship in 2 days

Connect EIA-232 devices to an EIA-485 network with SEL-2886 EIA-232 to EIA-485 Interface Converters.

	SEL-2800	SEL-2810	SEL-2812	SEL-9220	SEL-2814	SEL-2815	SEL-2820	SEL-2824	SEL-2829	SEL-2830	SEL-2831	SEL-2894
CONNECTOR AND OPTICS												
V-Pin, 650 nm Wavelength	•	•					•					
ST, 850 nm Wavelength			•	•	•	•		•				•
ST, 1,300 nm Wavelength									•	•		
ST, 1,550 nm Wavelength											•	
FIBER COMPATIBILITY												
200 µm Core Multimode Fiber (SEL-C805)	•	•	•	•	•	•	•	•				
50 or 62.5 µm Core Multimode Fiber (SEL-C807, SEL-C808)			•	•	•	•		•				•
9 µm Core Single-Mode Fiber (SEL-C809)									•	•	•	
ELECTRICAL FEATURES												
EIA-232 Asynchronous Serial Data	•	•	•		•	•			•	•		•
EIA-485 Asynchronous Serial Data				•			•	•				
DTE/DCE Switch					•	•			•	•		
IRIG-B Transfer With Data		•	•	•								
Hardware Flow Control Lines With Data					•			•				
Power From Electrical Port Pins	•	•	•	•	•	•			•	•	•	•
External Power Jack or Terminals					•		•	•				
DISTANCES												
Minimum (metric)	1 m	1 m	1 m	1 m	1 m	2 km	1 m	1 m	1 m	16 km	16 km	1 m
Minimum (U.S.)	3.28 ft	3.28 ft	3.28 ft	3.28 ft	3.28 ft	1.24 mi	3.28 ft	3.28 ft	3.28 ft	9.94 mi	9.94 mi	3.28 ft
Maximum (metric)	500 m	500 m	5 km	4 km	5 km	15 km	500 m	4 km	23 km	80 km	110 km	2 km
Maximum (U.S.)	0.3 mi	0.3 mi	3.1 mi	2.48 mi	3.1 mi	9.3 mi	0.3 mi	2.48 mi	14.3 mi	49.7 mi	68.3 mi	1.2 mi

• Standard feature

CABLES OVERVIEW

SEL-C804

Starting Price
$63 USD

selinc.com/products/C804
Select models typically ship in 2 days

Use SEL-C804 Multimode Arc-Flash Detection Fiber-Optic Cables with the SEL-751, SEL-751A, and SEL-710-5 to detect arc-flash events.

SEL-C805

Starting Price
$40 USD

selinc.com/products/C805

Connect V-pin or ST ports with SEL-C805 200 µm Multimode Fiber-Optic Cable assemblies.

SEL-C807

Starting Price
$50 USD

selinc.com/products/C807

Use SEL-C807 62.5/200 µm Multimode Fiber-Optic Cable assemblies to connect ST or LC ports.

SEL-C808

Starting Price
$52 USD

selinc.com/products/C808
Select models typically ship in 2 days

Connect ST, SC, or LC ports with SEL-C808 62.5/125 µm Multimode Fiber-Optic Cable assemblies.

SEL-C809

Starting Price
$55 USD

selinc.com/products/C809

Use SEL-C809 9 µm Single-Mode Fiber-Optic Cable assemblies to connect ST, SC, or LC ports.

ELECTRICAL DATA CABLES

Starting Price
$26 USD

selinc.com/products/electrical-data-cables
Select models typically ship in 2 days

Apply SEL Electrical Data Cables to reliably connect SEL products and other devices, including relays, information processors, computers, I/O modules, meters, clocks, and modems.

COAXIAL CABLES

Starting Price
$18 USD

selinc.com/products/coaxial-cables
Select models typically ship in 2 days

Use SEL Coaxial Cables for GPS and radio antenna connections and IRIG-B time distribution.

CATEGORY 5E ETHERNET CABLES

Starting Price
$30 USD

selinc.com/products/category-5e-ethernet
Select models typically ship in 2 days

Apply high-quality, shielded twisted-pair (STP) Category 5e Ethernet cables for copper Ethernet connections.

USB SERIAL CABLES

Starting Price
$15 USD

selinc.com/products/usb-serial
Select models typically ship in 2 days

Add a 1.8 m (6 ft) or 4.6 m (15 ft) EIA-232 serial port cable to a PC USB port to communicate with SEL relays and other devices with EIA-232 serial ports.

	SEL-C804	SEL-C805Z	SEL-C805D	SEL-C805G	SEL-C807Z	SEL-C807G	SEL-C808Z	SEL-C808P	SEL-C808G	SEL-C809Z	SEL-C809P	SEL-C809G
CONNECTOR												
V-Pin	•	•	•	•								
ST	•	•	•	•	•	•	•	•	•	•	•	•
LC					•	•	•	•	•	•	•	•
SC							•	•	•	•	•	•
FIBER DIAMETER (CORE/OUTER)												
1,000 µm	•											
200 µm		•	•	•								
62.5/200 µm					•	•						
62.5/125 µm							•	•	•			
9/125 µm										•	•	•
WAVELENGTH												
650 nm (Multimode)		•	•	•								
850 nm (Multimode)		•	•	•	•	•	•	•	•			
1,300 nm (Multimode)					•	•	•	•	•			
1,300–1,550 nm (Single-Mode)										•	•	•
FIBER COUNT												
Simplex (1 Fiber)	•	•			•		•	•		•	•	
Duplex (2 Fibers)	•	•	•	•	•	•	•	•	•	•	•	•
Quad (4 Fibers)			•	•		•			•			
CABLE RATINGS												
Riser-Rated (OFNR)		•	•		•		•		•	•		•
Plenum-Rated (OFNP)								•			•	
Water-Blocked			•									
Waterproof				•		•			•			•
JACKET MATERIAL												
Polyvinyl Chloride (PVC)		•	•		•		•	•	•	•	•	•
Polyethylene (PE)	•			•		•						
TERMINATION KITS												
V-Pin Termination Kit	•	•	•	•								
ST Termination Kit	•	•	•	•	•	•						
LC, ST, and SC Termination Kit							•	•	•	•	•	•
OPTIONS												
Bulk (No Connectors)	•	•	•	•	•	•	•	•	•	•	•	•
Pulling Loop			•	•		•			•			
FIBER-OPTIC COMPATIBILITY												
SEL-2800/2810/2820		•	•	•								
SEL-2812/2814/2815/2824/3405/9220		•	•	•	•	•	•	•	•			
SEL-2829/2830					•	•	•	•	•	•	•	•
SEL-2831										•	•	•
SEL-751/751A/710-5 Arc-Flash Detection	•											
Multimode Fiber-Optic Ethernet					•	•	•	•	•			
Single-Mode Fiber-Optic Ethernet										•	•	•

• Standard feature

ACCESSORIES AND TOOLS OVERVIEW

SEL-4388

Starting Price
$295 USD

selinc.com/products/4388
Select models typically ship in 2 days

Accelerate commissioning and bench testing of SEL MIRRORED BITS® links and improve training, maintenance, and cable identification with the SEL-4388 MIRRORED BITS Tester.

SEL-4520

Starting Price
$400 USD

selinc.com/products/4520
Select models typically ship in 2 days

Use the SEL-4520 Arc-Flash Test Module to conveniently test the operation of arc-flash detection relays installed in metal-clad and metal-enclosed switchgear.

SEL-2652

Starting Price
$200 USD

selinc.com/products/2652

Verify circuit breaker or lockout relay trip coil and trip circuit connections with the SEL-2652 Trip Coil Monitor.

SEL-9510

Starting Price
$300 USD

selinc.com/products/9510
Select models typically ship in 2 days

Use the SEL-9510 Control Switch Module everywhere independent local control is needed. High-visibility status indication and arc-suppressed contacts are particularly ideal for breaker control.

SEL-2126

Starting Price
$2,730 USD

selinc.com/products/2126

Apply the SEL-2126 Fiber-Optic Transfer Switch to reroute IEEE C37.94 communications for bypass breaker protection during circuit breaker or station bypass operations.

SEL-2910

Starting Price
$86 USD

selinc.com/products/2910
Select models typically ship in 2 days

Use the SEL-2910 Port Isolator to protect the EIA-232 ports of data terminal or communications equipment from induced voltages.

SEL-9501/9502

Starting Price
$84 USD

selinc.com/products/9501
selinc.com/products/9502
Select models typically ship in 2 days

Decrease maintenance costs, increase contact reliability, and reduce destructive dc circuit overvoltages with the self-powered SEL-9501/9502 Contact Arc Suppressors.

SEL-9321

Starting Price
$190 USD

selinc.com/products/9321
Select models typically ship in 2 days

Convert high-voltage dc battery sources for use with communications or instrumentation devices with the SEL-9321 Low-Voltage DC Power Supply.

SEL-9322

Starting Price
$150 USD

selinc.com/products/9322
Select models typically ship in 2 days

Apply the SEL-9322 15 Vdc Power Supply for ac-to-dc or dc-to-dc conversion in harsh physical and electrical environments, including those found in substations.

BOOKSTORE

Order online at **selinc.com/bookstore**

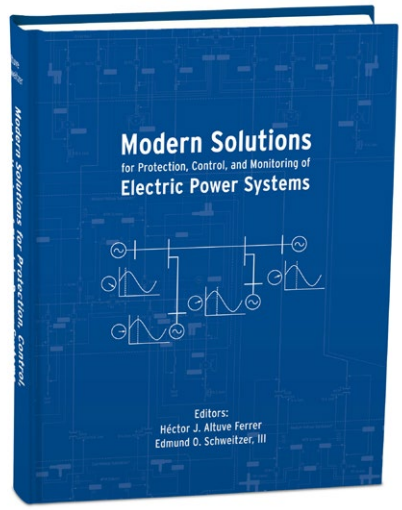
MODERN SOLUTIONS FOR PROTECTION, CONTROL, AND MONITORING OF ELECTRIC POWER SYSTEMS

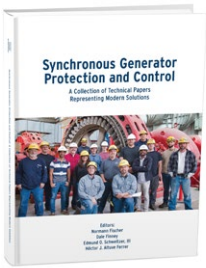
The most comprehensive work of its kind, this book consolidates new, modern solutions for protection, control, and monitoring of electric power systems.

You'll find straightforward presentations and example applications of the following technologies:

- Time-synchronized protection, control, and monitoring.
- Wide-area protection and control using synchrophasors.
- Sensible cybersecurity and a security-in-depth tool kit.
- Distribution systems that deliver safe operation and rapid power restoration after faults.
- Transmission protection solutions that improve stability, detect power swings, and help you get the most out of your primary equipment.

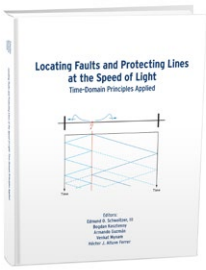
Spanish version available





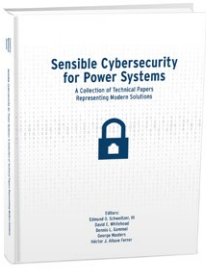
SYNCHRONOUS GENERATOR PROTECTION AND CONTROL

This book, composed of 27 technical papers, covers modern technologies for synchronous generator protection, control, and monitoring.



LOCATING FAULTS AND PROTECTING LINES AT THE SPEED OF LIGHT

This book, composed of 15 technical papers, explains traveling waves and instantaneous incremental quantities for line protection and fault locating.

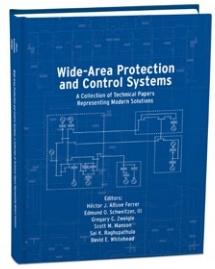


SENSIBLE CYBERSECURITY FOR POWER SYSTEMS

This book, composed of over 25 technical papers, provides an overview of power system cybersecurity challenges, opportunities, and solutions.

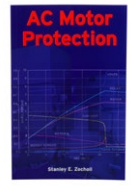
LINE CURRENT DIFFERENTIAL PROTECTION

This book, composed of 15 technical papers, addresses the design and application of line current differential protection, communications, and fault locating, from both the protection and communications perspectives.



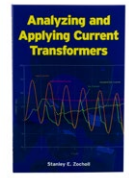
WIDE-AREA PROTECTION AND CONTROL SYSTEMS

This book, composed of 41 technical papers, covers the practical technology and solutions for wide-area protection and control that are in service today.



AC MOTOR PROTECTION

This book, written for the practicing engineer, covers ac motor characteristics and protection principles in a concise and practical way.



ANALYZING AND APPLYING CURRENT TRANSFORMERS

This concise book explains fundamental concepts for nonlinear characteristics, accuracy ratings, and transient behavior of current transformers.

SEL UNIVERSITY

SEL University trains power system and industrial professionals, meeting your immediate and long-term workforce training needs. We offer various training options, from fundamental power system protection, control, and monitoring principles to hands-on SEL product application and testing.

Aside from our high-quality course content and materials, our instructors are what truly set us apart. We provide the education and training you need, taught by our industry experts—the very same experts who design SEL equipment and solutions, support customers, and add to the field of knowledge through industry publications. We have nearly 200 certified instructors. Our instructors have trained tens of thousands of industry professionals worldwide.

COURSE TYPES

Power system—power system fundamentals for engineers.

Protection—power system protection fundamental principles and applications.

Communications—introductory and advanced networking and data communications fundamentals.

Application—hands-on settings and applications for SEL products.

Testing—hands-on relay testing and troubleshooting.

Systems—advanced hands-on integration and design.

CLASSROOM-BASED TRAINING

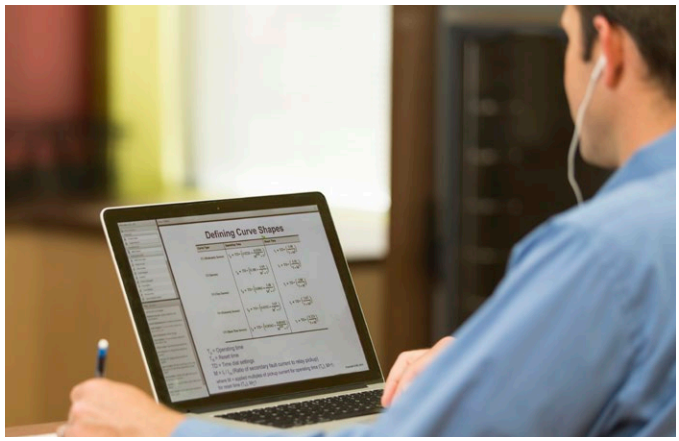
Regularly Scheduled Courses

- Learn at convenient locations around the world.
- Take fundamentals and hands-on training courses.
- Network with other industry professionals.
- Easily register online for scheduled courses.

Custom Training

In an industry where time is valuable and training is crucial, we provide training that comes to you and meets your needs. You supply the training room, and we provide the equipment, course materials, and instructors for your custom training.

- Create a tailored experience—mix and match standard course material to meet your needs.
- Reduce travel expenses, and train more employees at one time.
- Address your company's specific training needs in a confidential environment.



eLEARNING COURSES

SEL University offers computer- and web-based courses that give you flexible training options. These courses supplement and act as great precourses for traditional classroom courses. We offer two types of eLearning to best meet your needs.

Computer-Based Training (CBT)

Enjoy self-paced learning with our CBT courses. From our complimentary overview (CBT 101) to more detailed studies of specific SEL products, our CBT courses not only introduce our products but serve as the foundation for our in-depth, classroom-based courses. Our CBT courses address the needs of engineers and technicians alike.

With SEL University CBT courses, you can:

- Maximize your training budget.
- Access your content online at any time.
- Track your eLearning completion status using your mySELU Training Plan.
- Earn professional development hours with ease.
- Choose a corporate CBT license or an individual CBT license.

Web-Based Training (WBT)

WBT courses are held in real time with live instruction to provide an exceptional experience without the expense of travel. Our WBT course topics relate to our products, such as event retrieval and analysis or dual-breaker reclosing, as well as fundamentals topics, like pilot communications, security, and symmetrical components.

WBT courses enable you to:

- Maximize your training budget.
- Maintain flexibility in your schedule.
- Attend class from anywhere.
- Enjoy a learner-centered approach.
- Ask questions and share ideas with your instructor and your peers.
- Use homework assignments to practice the course material before follow-up discussions.
- Earn professional development hours with ease.

SEL UNIVERSITY

+1.509.338.4026 | selu@selinc.com | selinc.com/selu

ENGINEERING SERVICES OVERVIEW

PROTECTION

Protection Services
Protection solutions and related services for electric power systems, including scheme designs, relay settings, and more.

Substation Engineering Services
Comprehensive solutions for power and substation design projects, from initial cost estimates to a completed substation.

Arc-Flash Risk-Assessment Services
Flexible, customized arc-flash risk assessment services to improve employee safety and address regulations.

Transmission Planning Services
Transmission planning analysis and design services over a wide range of study scenarios from 69 kV to 525 kV.

Synchronizing Systems
Conventional and advanced generator and microgrid synchronizing systems with automatic and manual synchronizing.

Phase-Shifting Transformer (PST) Protection and Control Systems
Pre-engineered PST protection systems based on the SEL-487E Transformer Protection Relay.

Digital Secondary System Solutions
SEL Time-Domain Link (TiDL®) and SEL Sampled Values (SV) solutions that advance how you protect and control the primary equipment in your substation.

AUTOMATION

Automation Services
Proven automation and integration services using SEL technology, including solutions for SCADA, distribution network automation, and renewable energy control.

MOTORMAX® Low-Voltage Motor Management and Protection System
Centralized motor management system for comprehensive control, protection, analysis, and monitoring in motor control centers (MCCs).

Metering Services
Metering solutions for both producers and consumers of energy, including custom solutions for electric power, steam, water, or gas applications in new or existing facilities.

POWERMAX® POWER MANAGEMENT

POWERMAX Power Management Solutions
Integrated control systems composed of scalable relay and control hardware, software, and logic processing and designed by SEL experts.

POWERMAX for Industrial Power Management
Power management and control systems specifically engineered for industries with critical processes that need to stay online, improving power system reliability, personnel safety, and process uptime.

POWERMAX for Utilities
Custom solutions that maintain power system stability by detecting abnormal conditions and taking automatic corrective actions, including generation and load shedding and reactive compensation.

POWERMAX for Mobile Microgrids
Solutions that meet the needs of applications requiring mobility or rapid deployment, such as a military forward operating base (FOB) or a disaster relief effort.

POWERMAX for Garrison Microgrids
Dependable computing and communications, adaptive relaying, cybersecurity, and a TMS-MIL-STD-compliant microgrid controller that is interoperable with all makes and models of generators, inverters, and loads.

POWERMAX for Commercial Microgrids
Comprehensive control, protection, and metering systems to keep your power system operating when separated from the bulk electric grid.

CYBERSECURITY

Cybersecurity Solutions
Solutions to improve cyber defense, streamline ongoing management, and respond to incidents.

GENERAL ENGINEERING

Design and Drafting Services
Full substation design packages, site retrofits for existing electrical gear, and detailed design drawings for power system protection, automation, metering, and control.

Government Engineering Services
Innovative, technologically advanced power management services and solutions for municipalities and government organizations, including branches of the military, national laboratories, and governmental agencies.

Engineering Studies and Simulation Services
Hardware-in-the-loop (HIL) testing services, feasibility studies, coordination reports, system stability assessments, and more.

Custom Panel and Enclosure Solutions
Custom protection, control, and metering panels; control cabinets; and retrofit doors to match your specifications.

PROTECTION SERVICES

SEL Engineering Services specifies, designs, implements, tests, and commissions protection systems. Our engineers are experts at multifunction microprocessor-based relay technology, and we design protection schemes for generation, transmission, distribution, and low-voltage systems worldwide. We can provide all the design documentation, testing procedures, and setting reports for protection, control, automation, and communications systems.

selinc.com/solutions/protection-services

PROJECT SCOPE AND SPECIFICATION

SEL experts assist you from the conceptual phase of a project through execution and commissioning. Front-end engineering design services range from preliminary designs to complete project estimates.

SCHEME DESIGN

Schematics and diagrams prepared by SEL engineers help you take full advantage of SEL multifunctional technology for protection and automation schemes.

PROTECTION AND CONTROL RETROFIT DESIGN SERVICES

We help you reduce operating costs and improve the reliability of your aging systems by replacing outdated or unreliable equipment with SEL solutions. We have expert teams ready to meet your retrofit requirements.

RELAY SETTINGS

We program and configure protection and control equipment for a wide variety of applications.

PANELS AND ASSEMBLIES

SEL experts design, build, assemble, wire, package, and ship panels worldwide and also provide factory and onsite testing.

FIELD TESTING AND COMMISSIONING

Industry-trained SEL technical staff support field testing and commissioning onsite and provide hands-on training.

TRAINING

Application-specific training and SEL University courses for protection and automation technology increase the effectiveness of your operations and engineering staff.

NERC COMPLIANCE

SEL Engineering Services offers extensive services to support setting up NERC PRC standards compliance programs and completing NERC PRC compliance studies.

Our in-depth knowledge of NERC PRC standards and protection systems allows us to perform compliance verification studies and recommend innovative corrective-action plans for noncompliant protection systems. We have developed reports to clearly demonstrate NERC PRC compliance to auditors.

We have been building continuous monitoring for protection and control systems using microprocessor-based protective relays and real-time automation controllers since before NERC defined the term. Our engineers know industry best practices. Whether or not you need to comply with regulatory standards, we can audit your maintenance programs to determine areas for improvement. Our team of experienced engineers will demonstrate how to leverage the benefits of the IEDs already installed in your system to perform real-time validation and status reporting.

SUBSTATION ENGINEERING SERVICES

SEL Engineering Services provides comprehensive solutions for substation design projects. Our team has experience providing everything from initial cost estimates to a completed substation. Our experienced project management team provides permitting, scheduling, reporting, and procurement services. SEL licensed professional engineers walk your team through the conceptualization, estimation, budgeting, design, construction, and testing process. We have engineers with expertise in civil, mechanical, and electrical engineering; protection; system modeling, load flow, and short-circuit studies; automation; microgrid controls; networking; and cybersecurity.

selinc.com/solutions/substation-engineering-services

CONCEPTUAL DESIGN AND EVALUATION

To help establish all of the necessary site conditions, we offer:

- Project basis-of-design information.
- Field surveys, geotechnical investigations, and evaluation of existing utility and elevation layouts.
- Substation, distribution, and transmission planning, initial electrical studies, and analyses.
- Conceptual layout drawings and one-line diagrams.
- Desktop study reports, site surveys (digital and hard copy), and soil resistivity reports.

SUBSTATION DESIGN

Our team provides a clear path to completing your substation project, including permitting strategies, timelines, and technical support. The design phase includes detailed engineering calculations, bills of materials (BOMs), studies, analyses, plans, specifications, schedules, and cost estimates. We can provide:

- Civil engineering, including site layout, demolition and removal, erosion and sedimentation controls, site work, utility layout, foundations, steel structures, geotechnical investigations, equipment loading, yard stoning, and fencing.
- Electrical engineering, including grounding, major equipment (transformers, breakers, capacitors, reactors, underground cables, etc.) specification and design, duct bank design, cable and conduit sizing, lightning and surge protection, yard lighting, relay panel and control house design, control and protection design, wiring, and SCADA designs with analyses and studies (relay coordination, temporary overvoltage, harmonics, arc-flash hazards, etc.).
- Complete engineering substation services.

REQUEST FOR PROPOSAL (RFP) SERVICES

The SEL Engineering Services team provides the vital RFP services needed to prepare construction documentation for bidding. We can prepare RFP packages, submit them for bids, select bidders, and perform other activities to support the proposal process.

CONSTRUCTION SUPPORT

We provide many of the services necessary for a project's construction. We can serve as your advocate by performing contractor prequalification, evaluation, and selection and providing construction oversight, inspection, management, and record documentation.

ARC-FLASH RISK ASSESSMENT SERVICES

SEL custom arc-flash risk assessments help mitigate arc-flash hazards, improve employee safety, and address a variety of regulations (OSHA 29 CFR 1910.269, IEEE 1584b-2011, NFPA-70E-2018, NESC-2012, and CSA Z462-2015). We apply proven methods to create site-specific arc-flash mitigation and personal protective equipment (PPE) requirements. We can provide a complete, cost-effective arc-flash solution for your facility.

selinc.com/solutions/arc-flash-studies

POWER SYSTEM MODELING

SEL engineers create a three-phase computer model of your power system in an electrical one-line format, including facility-specific equipment and electrical data for all portions of the system.

SHORT-CIRCUIT STUDIES

Computerized short-circuit studies determine fault current levels at all electrical buses to as low as 208 V for multiple operating configurations.

PROTECTIVE-DEVICE COORDINATION STUDIES

SEL engineers enter existing fuse, relay, and circuit breaker protective device settings into a power system model to determine short-circuit clearing times. They create graphical coordination curves to prove selectivity with other protective devices.

ARC-FLASH ANALYSIS STUDIES

SEL engineers calculate arcing fault currents, determine protective device trip times, and report incident energy, flash boundaries, and PPE categories. Arc-flash software computes incident energy levels based on 100 and 85 percent of calculated arcing currents and reports the worst case. We provide arc-flash analysis studies for both ac and dc systems.

ARC-FLASH MITIGATION STUDIES

We investigate methods to reduce unacceptably high incident energy levels by modeling current-limiting solutions, reducing protective-device clearing times, implementing differential relaying schemes, and applying other economical solutions based on your system topology.

ARC-FLASH HAZARD WARNING PLANS

SEL engineers provide customized arc-flash and shock hazard warning and danger labels that detail boundary distances, arc-flash energy levels, PPE classification levels, and other data.

ARC-FLASH ENGINEERING REPORTS

We compile the results of each study into an engineering report, which includes the power system model for your facility.

FIELD SURVEYS

We also do the following to assist in surveying your facility:

- Obtain and verify electrical equipment nameplate data.
- Record equipment nominal and short-circuit ratings.
- Record the cable types, sizes, lengths, and insulation.
- Document the electrical system topography.
- Record circuit breaker and relay settings.

DETAILED ENGINEERING STUDIES

If the ratings of existing equipment are inadequate, we can help evaluate alternatives. These studies typically examine ways to redesign the existing electrical system to fix problems, keep personnel safe, and save money.

TRANSMISSION PLANNING SERVICES

The purpose of transmission planning is to maintain reliability, security, and stability while meeting current and future system needs. Transmission planning requirements and processes vary by region. The experienced team at SEL creates transmission plans and analyses that are uniquely suited to meet the requirements for your region over a wide range of study scenarios, from 69 kV to 525 kV.

selinc.com/solutions/transmission-planning

STUDIES FOR EVERY SITUATION

Using the GE Positive Sequence Load Flow (PSLF) software package and custom tools, we perform the following services:

- Path-rating studies
- FERC generator interconnection studies
- Wires-to-wires interconnection studies
- NERC MOD-026, MOD-027, PRC-006, PRC-019, PRC-024, and PRC-025 compliance studies
- Import/export studies
- Load-serving studies
- Underfrequency load-shedding (UFLS)/undervoltage load-shedding (UVLS) studies
- Wind turbine studies
- Microgrid studies
- Transformer emergency loading above nameplate rating calculations
- Overhead conductor steady-state thermal rating studies
- Protective-relay coordination studies

Even if you are not required to perform these specific types of analyses, you can benefit from transmission planning best practices. We provide hard and electronic copies of all reports and models for future use. It is easy to update system models for future planning needs, saving time and money versus creating new models.

POWERFUL SOFTWARE TOOLS

Our team can analyze and provide recommendations for a variety of planning and operating power system scenarios. Software tools we use include the following:

- GE PSLF and ProvisoHD
- Electrocon International's Computer-Aided Protection Engineering (CAPE)
- MathWorks Simulink & Simscape
- AspenTech's Aspen short-circuit programs
- Custom routines

With these tools, SEL engineers can perform transient stability, post-transient, and voltage/thermal analyses as well as relay coordination.

APPLICATIONS

The results of transmission planning studies can help you:

- Determine facility equipment and operating practices to reliably meet existing and future load needs.
- Identify the facilities needed for new generators while meeting generator interconnection requirements.
- Fulfill compliance requirements for national and regional modeling and planning standards.
- Perform transmission regulatory studies to meet regional resource planning statutes.
- Provide recommendations to mitigate local and wide-area power system disturbances.
- Alleviate system bottlenecks to eliminate or delay the need for new infrastructure.

SYNCHRONIZING SYSTEMS

SEL Engineering Services provides both custom and pre-engineered synchronizing systems. These systems adjust the frequency and voltage of the generator or microgrid to bring the frequency difference (slip) and voltage difference into the synchronizing acceptance band and energize the breaker close coil at the slip-compensated advanced angle close. An SEL relay with advanced sync-check functionality at each point of coupling provides sync-check supervision and/or the close command when parameters are acceptable to close the breaker connecting two power systems together.

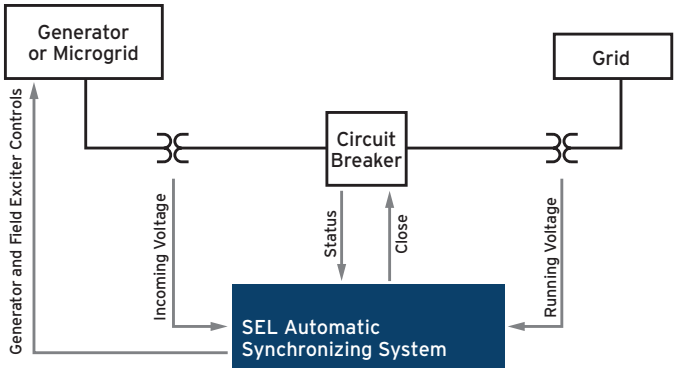
selinc.com/solutions/synchronizing-systems

ADVANCED SYSTEMS

SEL engineers can create custom solutions for applications such as resynchronizing islands, remote synchronization with fiber-optic communications, flexible systems with internal PT signal switching between as many as six PT inputs, systems requiring communications and integration with distributed control systems, systems requiring HMI visualization, and many others.

AUTOSYNCHRONIZATION SYSTEMS

SEL autosynchronizers replace the synchronizing panel hardware and circuits required for manual breaker closing. Autosynchronizers are more precise than manual systems, and SEL solutions include advanced reporting, communications, protection-class equipment, and high-speed communications.



The SEL synchronizing system can include automatic and manual controls to locally close the breaker on achieving synchronism.

SCALABLE SOLUTIONS

SEL synchronizing solutions are scalable to meet your needs, whether your system consists of small emergency generators or large utility generators. You can synchronize multiple machines across multiple locations and set different parameters to optimize each synchronizing scenario using multiple settings groups and flexible logic.

PRE-ENGINEERED AND CUSTOMIZED SOLUTIONS

We can build a synchronizing system based on the autosynchronization functions in the SEL-700G Generator Protection Relay. Alternatively, we can provide more advanced systems built around a pre-engineered autosynchronizer using the SEL-451 Protection, Automation, and Bay Control System (when purchased with a separate configuration and documentation CD). You can select a standard, pre-engineered SEL-451 autosynchronizer, or we can provide a customized solution that fits the exact needs of your project, operational procedures, and specifications.

PHASE-SHIFTING TRANSFORMER (PST) PROTECTION AND CONTROL SYSTEMS

SEL Engineering Services provides PST—also known as a phase angle regulating (PAR) transformer—protection and control systems. We have extensive experience with modeling, designing, setting, and testing protection and control systems for the many different configurations of these unique transformers.

selinc.com/solutions/protection-services

COMPREHENSIVE PROTECTION IN A SINGLE RELAY

SEL provides a pre-engineered PST protection system based on a single SEL-487E Transformer Protection Relay. Traditional protection for conventional, two-core PSTs requires separate differential relays to cover the primary windings (87P) and the secondary windings (87S) of the series and excitation transformers. Typically, four relays are required to provide a redundant protection system. The SEL solution provides both sets of differential elements in a single SEL-487E relay so that only two relays are necessary to provide fully redundant electrical protection.

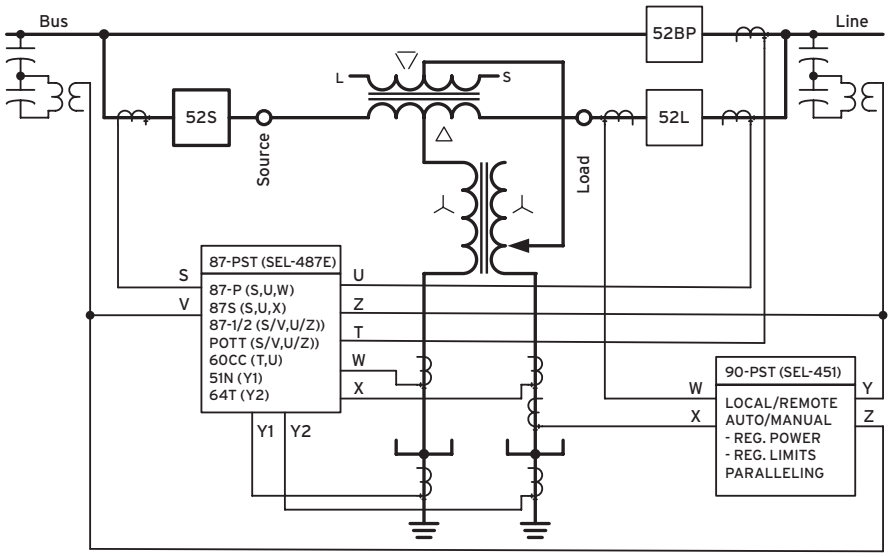
Traditional 87P and 87S elements are blind to turn-to-turn faults in the regulating windings of a PST, where partial winding faults are most likely to occur. SEL supplements the 87P and 87S elements with patented positive- and negative-sequence differential elements (87-1 and 87-2) that compensate for the variable phase shift introduced by the PST. These elements are sensitive to all in-zone fault types, including turn-to-turn faults in the regulating winding of the PST. This significant advancement in PST protection is included in IEEE C37.245-2018.

These patented elements only require CTs at the zone boundaries (source and load sides) and do not require CTs embedded inside the PST, as conventional protection does. This unique capability also makes the SEL PST protection system suitable for modernizing the protection of PSTs without CTs in the correct locations to implement conventional protection.

Additionally, this comprehensive solution provides bypass-off-neutral protection (60CC), system ground backup (51N), and secondary winding ground protection (64T). Primary winding restricted earth fault protection is inherently provided by the 87P elements.

PRE-ENGINEERED AND CUSTOM ON-LOAD TAP CHANGER CONTROL SYSTEMS

Traditionally, PSTs have been limited to manual control due to the complexities of automatically regulating real power flow on the grid. SEL has developed technology to automatically control the on-load tap changers that regulate the power flow through a PST. We adapt our extensive library of solutions to the unique needs of your power flow control applications. Our capability includes controls for automatically operating parallel PSTs as well as redundant master/hot-standby automatic control systems.

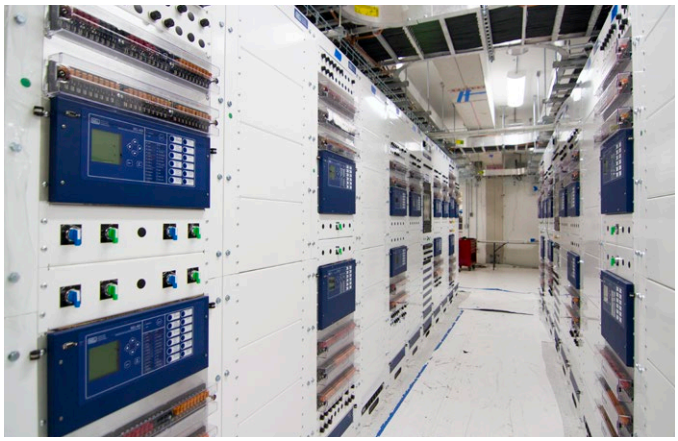


DIGITAL SECONDARY SYSTEM SOLUTIONS

Digital secondary system solutions advance how you protect and control the primary equipment in your substation. These solutions reduce substation construction and expansion costs, improve personnel safety, and increase flexibility by replacing copper with fiber. You can modernize your substation by choosing from two SEL digital secondary system solutions:

- SEL Time-Domain Link (TiDL®) technology—a protection-centered, point-to-point solution that eliminates complex Ethernet network design.
- SEL Sampled Values (SV) technology—a communications-centric, network-based solution that combines protection in the merging unit with the flexibility of IEC 61850-9-2.

selinc.com/solutions/p/digital-secondary-systems



SEL SV TECHNOLOGY

SEL SV combines protection in the merging unit with the flexibility of IEC 61850-9-2. The merging unit (publisher) digitizes analog signals from primary equipment and then transmits them to an SV-supported relay (subscriber) in the control house via an Ethernet network.

Merging Units With Built-In Protection

In an SEL SV solution, the SEL-401 Protection, Automation, and Control Merging Unit provides overcurrent and breaker failure protection and the SEL-421 Protection, Automation, and Control Merging Unit provides complete line protection, including five zones of subcycle mho and quadrilateral distance elements. If IEC 61850 network communications are lost, the SEL merging units provide backup standalone protection.

Interoperability

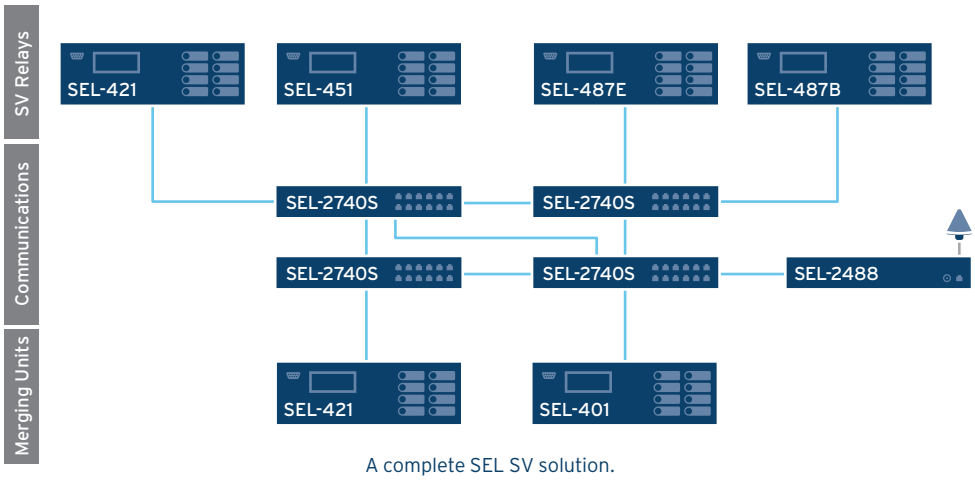
SEL SV devices are fully compliant with IEC 61850-9-2 and the UCA 61850-9-2LE guideline. You can use them with primary equipment that generates SV streams or with other manufacturers' SV-compliant units.

Unique Testing and Troubleshooting Tools

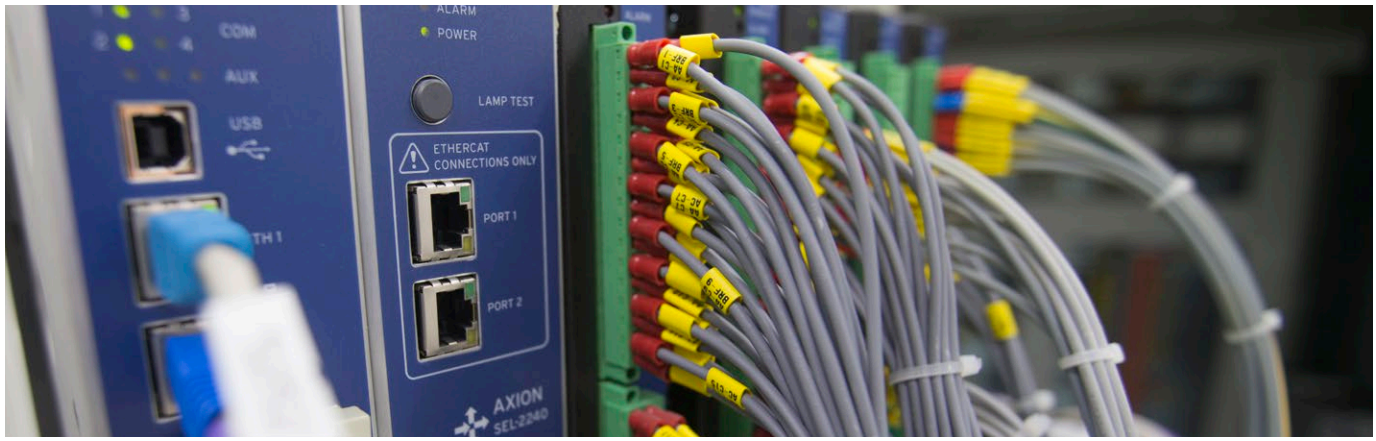
The COM SV command in SEL merging units provides you with information about your SV configuration, including warning and error codes that detail why a relay rejected an SV stream, which aids troubleshooting. The TEST SV command allows you to check the network connectivity and the CT and PT ratios between publisher and subscriber devices.

Flexible Ethernet Network

SEL SV technology allows you to create a flexible Ethernet-based point-to-multipoint network using tools such as software-defined networks or VLANs to fit your application needs. You can use the SEL-2740S Software-Defined Network Switch to provide centralized traffic engineering and improve Ethernet performance. The switch acts as a transparent Precision Time Protocol clock that supports the IEEE C37.238 power system profile, ensuring submicrosecond time synchronization of the end devices.



A complete SEL SV solution.

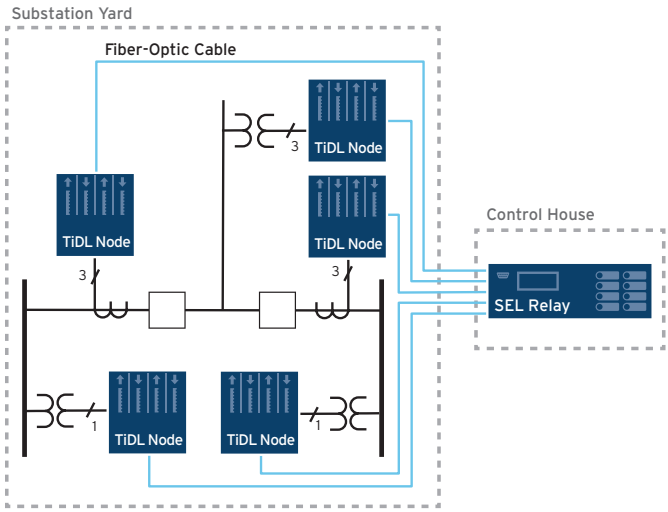


SEL TIDL TECHNOLOGY

TiDL technology is an innovative digital secondary system solution engineered with simplicity in mind. This technology requires no external time source, has strong cybersecurity, and is easy to implement, with no network engineering required.

Simple Architecture

TiDL nodes are placed in the yard close to the primary equipment. They act as field modules to digitize discrete I/O signals and analog data, such as voltages and currents. These data are then transported over fiber-optic cables to a TiDL-enabled relay in the control house. In this simple point-to-point architecture, each TiDL node is paired with one TiDL-enabled SEL-400 series relay. Because TiDL is a point-to-point architecture, implementation is simple and requires zero network engineering.



TiDL uses a simple point-to-point architecture.

No External Time Reference

TiDL maintains relative time; therefore, it does not rely on an external time reference for protection. All data from remote TiDL nodes are synchronized with each other regardless of the number of nodes connected to the relay or the length of the fiber.

Minimal Training Required

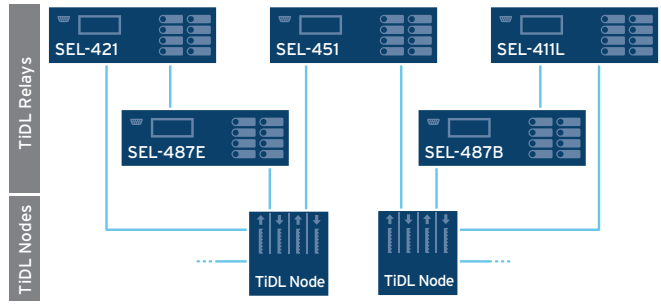
TiDL-enabled relay settings are the same as those in the popular SEL-400 series models, providing consistency and simplicity. You can use the same protection schemes and applications for complete distance, feeder, bus, and transformer protection.

Strong Cybersecurity Posture

The dedicated, deterministic TiDL system helps secure mission-critical systems. The isolated point-to-point connections and the absence of switches and routers reduce the electronic security perimeter and limit attack points. This security-minded architecture prevents remote access, and its simplicity eliminates the need for managing port access.

Next-Generation TiDL

The future of TiDL technology includes all the benefits of the existing solution as well as data sharing among multiple relays. This new capability will give you flexibility on how to best design protection for your system.

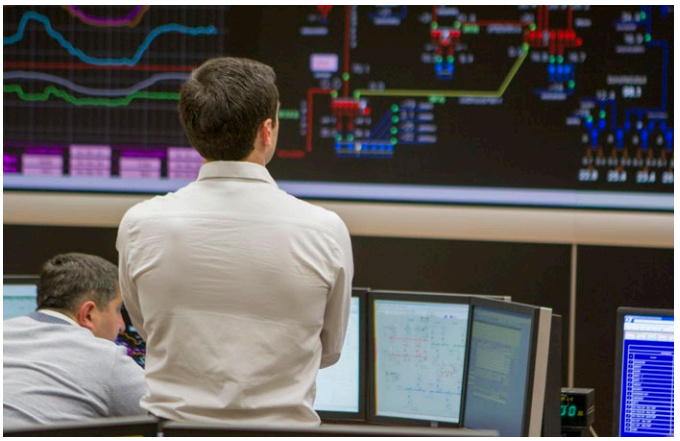


Data sharing will be part of TiDL's future.

AUTOMATION SERVICES

SEL Engineering Services offers proven automation and integration solutions using SEL technology. These solutions support electrical power system substations, commercial buildings, industrial sites, generation plants, and manufacturing sites worldwide. This includes fully configured, tested, and documented settings for networking, control, communications, automation, and protection equipment. We also provide complete substation upgrades and replacement of legacy protection and remote terminal units (RTUs); event monitoring, collection, and analysis; and IED integration. Many standard SEL designs are scalable with various interfaces. We can also engineer individual solutions to meet specific requirements.

selinc.com/solutions/automation-services



SCADA SOLUTIONS

We design, develop, test, and deploy complete SCADA systems to monitor and control your systems or processes. We have experience providing systems of various sizes, ranging from simple standalone systems to complex networked systems. These SCADA systems include the following components:

- Master and local substation HMIs
- Station- and system-wide Sequential Events Recorder (SER)
- System-wide relay event retrieval
- Master SCADA server redundancy
- Remote access
- Enterprise and local power system report managers

DNA® (DISTRIBUTION NETWORK AUTOMATION)

SEL DNA systems increase system operational efficiency and reduce operating costs to provide affordable and reliable electric service. Our DNA systems combine fast protection with flexible automation control and communications for a distribution automation solution that makes your system safer, more reliable, and more economical. The SEL Distribution Automation Controller (DAC) System is an add-on feature for SEL Real-Time Automation Controllers (RTACs). The DAC provides automatic reconfiguration of distribution networks to restore power to as many customers as possible after system events, such as permanent faults and open-phase conditions. Optionally, the DAC can also provide dynamic feeder optimization, which automates control of voltage- and VAR-regulating devices to achieve goals such as power factor correction and demand reduction.

CONDITION-BASED MONITORING

SEL engineers use proven methods to integrate condition-based monitoring systems from multiple vendors into a comprehensive system that monitors the health of your power system. We integrate third-party systems for monitoring transformers, motors, circuit breakers, adjustable-speed drives, generators, uninterruptible power supplies, dc chargers, partial discharge, busbar joints, vibration, the environment, and cables.

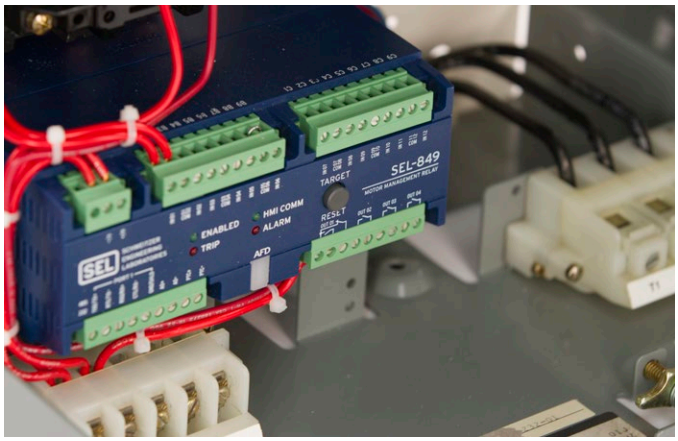
RENEWABLE ENERGY CONTROL

We offer a control system that enables renewable energy installations with dynamic VAR sources to meet utility interconnection and regulatory requirements. The SEL Grid Connection Control System is an add-on feature for SEL RTACs. It simplifies interconnection control and solves common interconnection issues, such as adapting for varying cloud cover, nonresponsive inverter controls, and unexpected voltage excursions. The control system contains pre-engineered function blocks for controlling the point of interconnection (POI) between the utility grid and a power generation source. Using the SEL pre-engineered control system library gets renewable projects online sooner than developing custom, project-specific controls.

MOTORMAX® LOW-VOLTAGE MOTOR MANAGEMENT AND PROTECTION SYSTEM

MOTORMAX is a centralized motor management system that provides comprehensive control, protection, analysis, and monitoring for original equipment manufacturer (OEM) motor control centers (MCCs). It incorporates low-voltage motor control into an overall plant control system. MOTORMAX also works with the SEL POWERMAX® Power Management and Control System for a single-source, fully integrated solution.

selinc.com/solutions/motormax



ARCHITECTURE

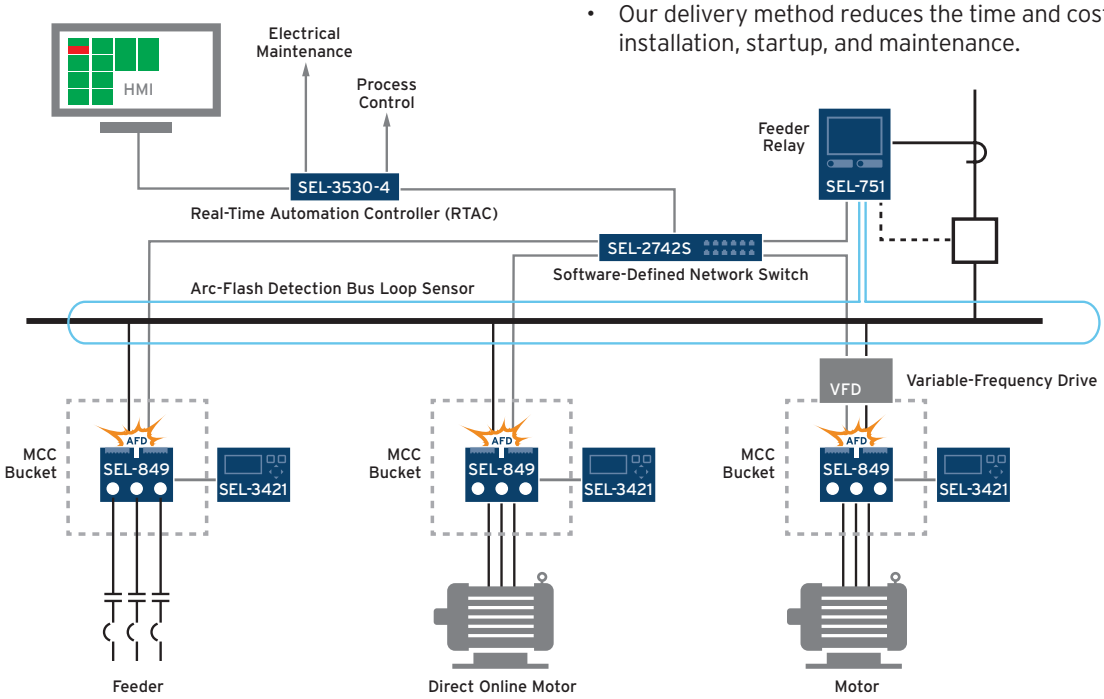
MOTORMAX is a combination of motor protection, network management, and real-time automation control. It uses the SEL-849 Motor Management Relay and features from other key devices, such as the communications abilities in SEL Real-Time Automation Controllers (RTACs) and managed Ethernet switches. Together, these devices deliver high-performance motor protection as well as high-speed reporting of motor status, alarms, and operating conditions at the HMI.

SYSTEM DELIVERY

We preconfigure and test all relay, network, and automation control settings to your specifications before shipment. Every system is delivered with a complete test report, a bill of materials, cabling, and labels to simplify onsite installation. A fully tested, preconfigured system reduces installation and commissioning time.

BENEFITS OVER A TRADITIONAL MCC

- Seamless integration with POWERMAX allows operators to manage a facility's power system, including end devices, from a single HMI screen.
- The absence of programmable logic controllers (PLCs), associated wiring, pushbutton controls, and interposing relays minimizes interconnect cabling.
- Arc-flash detection (AFD) increases safety by reducing incident energy. All incoming breakers are signaled to trip in <16 ms after an arc event anywhere in the MCC.
- SEL-849 Relays and SEL-751 Feeder Protection Relays provide more data than traditional MCC components, which gives a better insight of end device operation.
- By using SEL components, the system can achieve higher safety integrity level (SIL) ratings.
- Oscillography and Sequence of Events (SOE) recording enable online diagnostic analysis.
- Our delivery method reduces the time and cost of installation, startup, and maintenance.



MOTORMAX provides complete management, protection, and arc-flash remediation for small and large MCCs with any combination of direct online motors, variable-frequency drives, and feeders.

METERING SERVICES

SEL Engineering Services provides solutions that ensure the accurate, precise, and reliable operation of meters and support devices. By using best practices, experienced engineers, industry-leading technology, and a gated quality control process, the SEL team can design the best metering solution for your electric power, steam, water, or gas application.

selinc.com/solutions/metering-solutions

SYSTEM DESIGN AND CONFIGURATION

Whether for new or existing facilities, we can design metering systems that fit your budget and needs. We provide the following solutions to both producers and consumers of energy:

- Meter programming
- Metering system design
- Power quality studies
- Energy consumption studies
- Onsite accuracy testing and verification
- Metering asset integration
- Demand response and leveling system design
- Campus submetering design
- Pulse input conversion from conventional meters to ACSELERATOR® Meter Reports SEL-5630 Software

INTEGRATION SERVICES

Our team provides three tiers of metering asset integration services to deliver custom systems with high reliability and low maintenance costs. We offer:

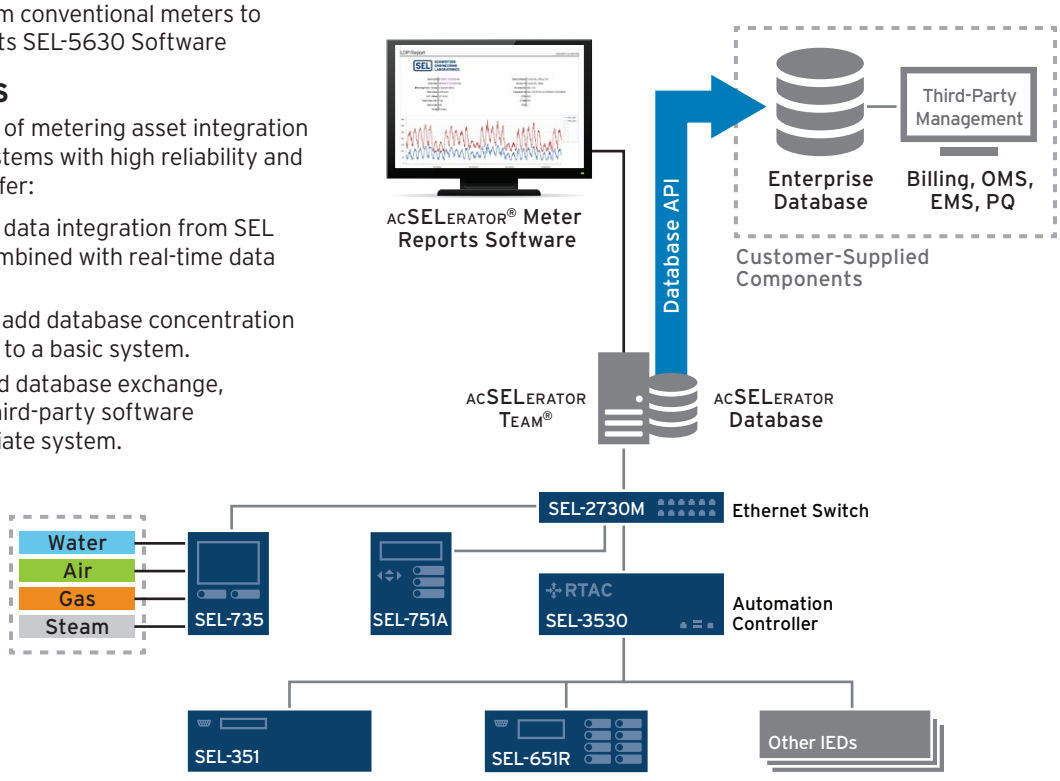
- Basic systems that include data integration from SEL and third-party devices combined with real-time data visualization.
- Intermediate systems that add database concentration and historical visualization to a basic system.
- Advanced systems that add database exchange, customized reports, and third-party software integration to an intermediate system.

POWERFUL DATA

Accurate metering data improve an asset's or system's performance and help you make better decisions. Experienced SEL engineers can also help you analyze your metering data to better understand your assets and processes.

TIME ALIGNMENT

With large campus metering systems, it is important that the system be time-aligned. We design solutions that incorporate time-aligned Sequence of Events (SOE) reporting to help you better understand event causes and effects across your system. Oscillography is available to assist with troubleshooting without the need for additional test equipment.



SEL solutions simplify site-wide metering and system integration.

POWERMAX® POWER MANAGEMENT SOLUTIONS

An SEL POWERMAX Power Management and Control System is an integrated control system composed of protective relays, controllers, networks, and software and designed by our engineering services experts. These systems prevent electric power system blackouts.

selinc.com/solutions/powermax-controls

SEL has designed, tested, and commissioned POWERMAX systems for military, utility, and industrial customers across the globe. Our solutions are based on sound engineering principles, robust system architectures, and industry-leading protection, automation, computing, communications, and security products. POWERMAX systems provide relay-speed operation across wide areas. These solutions are scalable, starting with the control of a simple, isolated microgrid up to a complex wide-area power system. For a single-purchase solution, you can select a complete, cyber-secure POWERMAX protection, control, and automation solution. Each solution is tailored in both complexity and cost for your needs. For small-scale microgrid or distributed energy resource (DER) control, we also offer simple solutions using the standalone SEL relays and Real-Time Automation Controllers (RTACs).

POWERMAX SOLUTIONS

Solution	POWERMAX for Mobile Microgrids	POWERMAX for Garrison Microgrids	POWERMAX for Commercial Microgrids	POWERMAX for Industrial Power Management	POWERMAX for Utilities
Example Applications	Military, disaster relief agencies, mobile operations	Military bases, energy service companies (ESCOs)	Universities, communities	Heavy industries	Utility
Power Consumption	<0.5 MW	>10 MW	<10 MW	>100 MW	>1,000 MW

POWERMAX® FOR INDUSTRIAL POWER MANAGEMENT

selinc.com/solutions/powermax-controls

A POWERMAX system increases process uptime by protecting against blackouts with advanced high-speed protection and control technology. Any production facility with onsite generation will benefit from the stability and protection of a POWERMAX system. These solutions offer:

- Load-shedding systems.
- Steam controls.
- Generation-shedding and runback systems.
- Autosynchronization systems.
- Fast decoupling solutions.
- Generation control systems.
- Factory acceptance tests.
- Control system simulations.
- Cybersecurity.
- Synchrophasor monitoring and control.
- MOTORMAX® Low-Voltage Motor Management and Protection System.

POWERMAX improves personnel safety and reduces equipment damage with adaptive protection, advanced protection systems, and arc-flash mitigation. POWERMAX also improves total system awareness with time-synchronized condition monitoring systems, which keep track of equipment status, electrical metering, cyber attacks, network traffic, and more.

POWERMAX technology is proven to keep facilities running and is specifically engineered for industries with critical processes that need to stay online. These facilities include:

- Oil and petrochemical refining operations.
- Pulp and paper manufacturing facilities.
- Mining and metals processing facilities.
- Water and wastewater treatment plants.
- Data centers.

POWERMAX® FOR UTILITIES

selinc.com/solutions/powermax-ras-utilities

A POWERMAX system for utilities uses a remedial action scheme (RAS) in a control system for large geographic regions of interconnected transmission, generation, and loads. Distributed computing and communications provide smart transmission grid management for integrating renewable generation and DERs. This solution is commonly used for the wide-area monitoring, control, and integration of large wind power stations.

A POWERMAX RAS integrates with existing relays, meters, and communications systems to minimize the footprint and complexity.

With a POWERMAX RAS, utilities can function closer to stability limits, operating transmission corridors at a higher capacity than ever before. In some cases, utilities can transmit over 50 percent more power across existing transmission lines. This increases daily revenues and can free up billions of dollars to enhance existing transmission lines instead of building new lines.

Advanced applications, such as SEL-5078-2 SYNCHROWAVE® Central Software, provide continuous monitoring of system diagnostics.

POWERMAX® FOR MOBILE MICROGRIDS

selinc.com/solutions/microgrids-fob

POWERMAX ensures reliable power for microgrids that require mobility or rapid deployment, such as a military forward operating base (FOB) or a disaster relief effort.

For FOB military applications, you can parallel diesel generators instead of using the traditional setup of a dedicated generator per B-Hut or tent. Instead of sizing a generator to the peak demand of the respective function (e.g., tactical operations center, mess hall, or medical facility) and running it inefficiently most of the time, FOBs can now have parallel generators. This allows you to run a few diesel generators at high efficiency while resting the remaining generators. As loads increase, you can bring more generators online to meet the demand. This process increases operational efficiency by reducing wet stacking (and maintenance) and saving fuel, which prolongs mission operations and increases resiliency.

What makes SEL's TMS-MIL-STD-compliant microgrid unique is that it works with all makes and models of generators, inverters, and loads. You can easily retrofit existing commercial off-the-shelf and tactical microgrid system (TMS) generators in the field with an SEL control system.

POWERMAX FOR GARRISON MICROGRIDS

selinc.com/solutions/microgrids

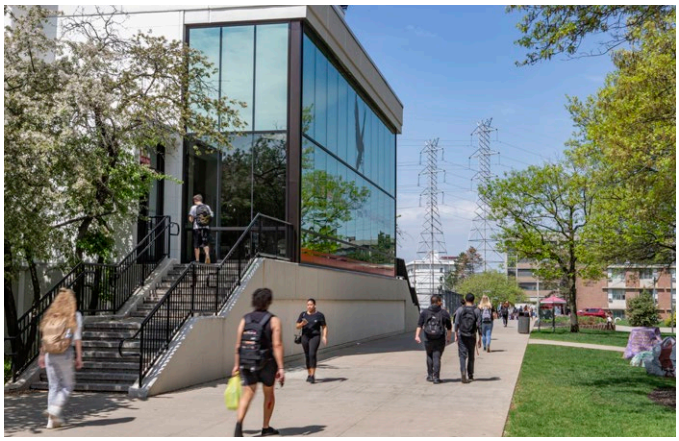
POWERMAX uses dependable computing and communications, including adaptive relaying and cybersecurity, to provide high-performance control for garrison microgrids. SEL control algorithms and demand response operate fast enough to preserve the load and generation energy balance, maintain system stability and, most importantly, make sure the base is operating at all times.

For military installations that use backup diesel generation, POWERMAX can parallel existing diesel generators. The benefits of paralleling include wet-stacking correction and fuel savings, which prolong mission operations and increase resiliency since there is no failure if a generator, cable, or building is destroyed.

What makes the SEL solution unique is a TMS-MIL-STD-compliant microgrid controller that works with all makes and models of generators, inverters, and loads. If your device communicates, we can connect, control, and parallel it. Additionally, you do not have to procure the entire control system up front but can purchase and build your system in blocks over time as funding permits.

POWERMAX® FOR COMMERCIAL MICROGRIDS

selinc.com/solutions/microgrids



SEL POWERMAX commercial microgrids keep the lights on, seamlessly islanding and reconnecting with the bulk electric system. POWERMAX microgrid control systems are efficient, reliable, and secure solutions for guaranteeing uninterrupted energy delivery to your facility and customers. They control and protect both renewable and conventional generation. SEL systems allow you to operate independently, ensuring a constant supply of energy after the loss of the utility point of common coupling (PCC). POWERMAX also lets you manage energy storage to maximize renewable generation and reduce peak charges.

In 2018, the SEL POWERMAX won the National Renewable Energy Lab microgrid shootout, a rigorous 21-week microgrid control and cybersecurity evaluation competition that pitted SEL microgrid controller technology against four competitors. SEL was also selected as the top microgrid provider by Navigant Research as part of their "Navigant Research Leaderboard: Microgrid Controls" report.

Every POWERMAX commercial microgrid control system includes a factory acceptance test (FAT) for you to attend. SEL owns and operates the largest for-lease controller hardware-in-the-loop (cHIL) testing facility in North America. This facility contains a large number of Real Time Digital Simulator (RTDS) racks used exclusively for cHIL testing of SEL protection and control systems under realistic conditions. During the FAT, you can observe and verify the full functionality of the system.

Factory acceptance testing in the SEL Solution Delivery Center.

CYBERSECURITY SOLUTIONS

Now more than ever, cybersecurity is vital for the protection of critical infrastructure. With extensive operational technology (OT) and cybersecurity expertise, the SEL Secure Solutions team builds effective solutions that improve cyber defense and streamline ongoing management. SEL central asset management solutions maintain system health throughout their life cycle. In addition, the SEL Security Operations Center (SOC) provides continuous support for system analytics, reporting, incident response, and forensics. We offer secure solutions across the five functional areas of the National Institute of Standards and Technology (NIST) cybersecurity framework.

selinc.com/solutions/sfci/professional-security-services

IDENTIFY

Identify vulnerabilities as the first step to improve cybersecurity. We offer:

- Assessment services, including development of compliance, risk, and remediation plans.
- Development of strategic cybersecurity roadmaps.
- Governance, risk, and compliance reviews and recommendations.
- Consultant services.

PROTECT

Provide ongoing protection of your OT system with SEL solutions, including:

- Centralized user access controls.
- Password management.
- Secure remote access.
- Integrated physical security with cybersecurity controls.
- Networking for substation LAN/WAN.
- Security hardening guides.
- Security Technical Implementation Guides (STIGs).
- Cybersecurity interconnection requirements.
- Whitelisting/blacklisting.
- System backups.
- Turnkey program management and integration.

DETECT

Reliably detect cybersecurity events on your system. We offer:

- Centralized asset management software.
- Centralized update management, including firmware, patches, antivirus signatures, and the Microsoft Windows Server Update Service.
- Baseline monitoring.
- System health monitoring.
- System cybersecurity compliance.
- Host-based and network-based intrusion detection systems (IDSs).
- Security information and event management (SIEM) systems for event logging and alerts.

RESPOND

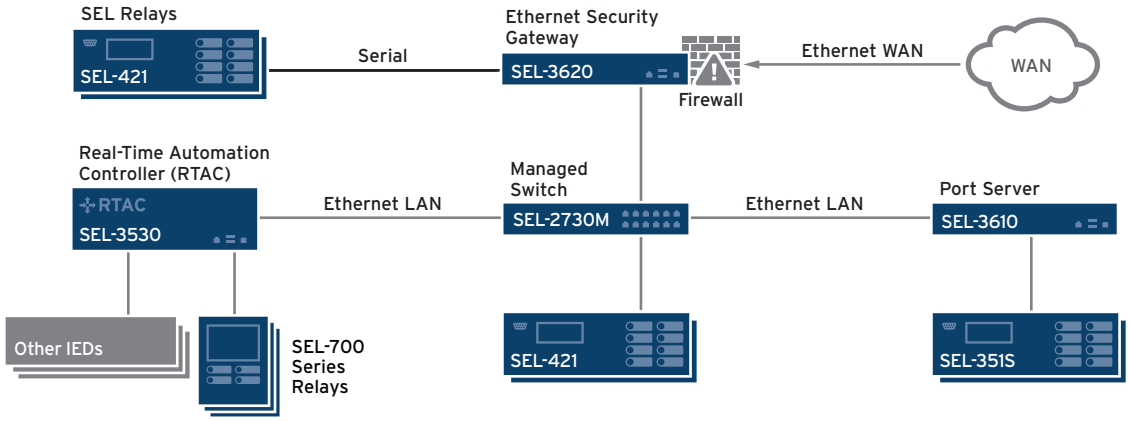
Ensure that your organization responds effectively to cybersecurity events. SEL solutions include:

- SEL SOC for system analytics and monitoring.
- System and cybersecurity training.
- Incident response and forensics.
- Alarms and alerts.

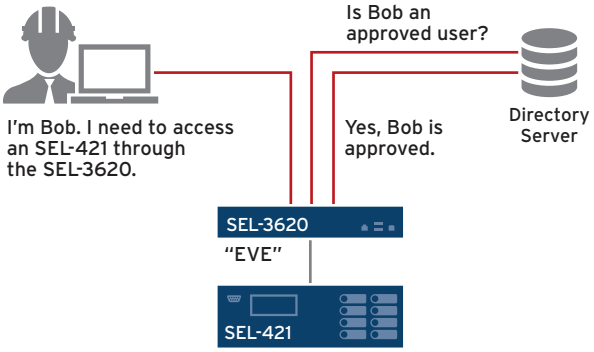
RECOVER

Promptly restore your system with SEL services, including:

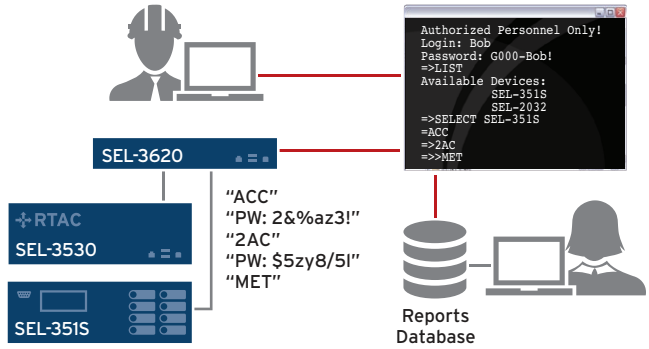
- System recovery.
- Resource augmentation.
- Spare parts inventory.



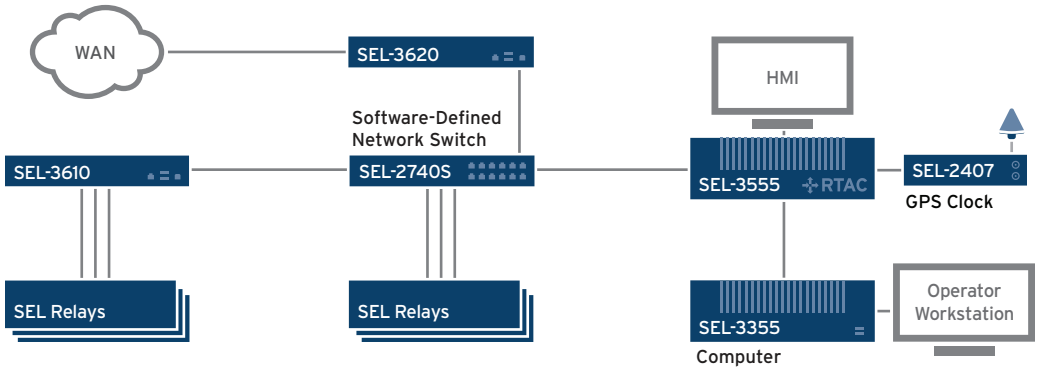
Provide strong access control for your electronic security perimeter.



Gain centralized user authentication.



Verify security compliance with user activity reports.

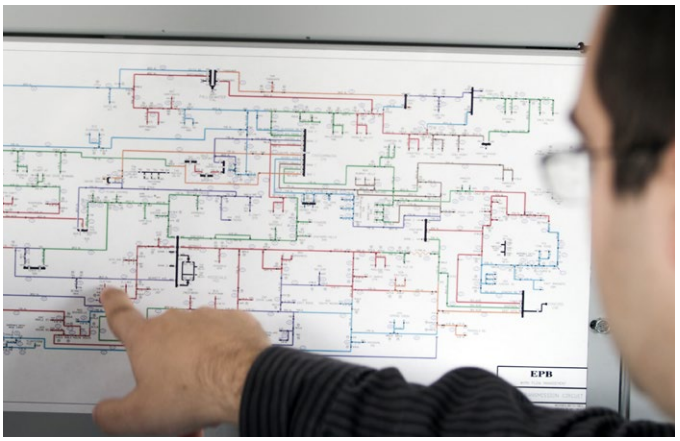


Apply secure deterministic Ethernet networks with SEL software-defined networking (SDN).

DESIGN AND DRAFTING SERVICES

SEL Engineering Services provides local design and drafting services for power and control systems, including critical infrastructure projects, around the world. We create new design and drafting packages and revise existing drawings. The team's drafting processes ensure the final design package is accurate and delivered on time.

selinc.com/solutions/design-and-drafting-services



COMPLETE DESIGN PACKAGES

Our experts offer full design packages that include ac and dc schematics, one-line diagrams, wiring diagrams, panel layout drawings, logic schematics, and communications and network drawings. We can also convert existing plastic sheet (Mylar), vellum, and paper drawings into electronic files for easier access and storage.

VERSATILITY

SEL Engineering Services supports multiple software tools to accommodate your preferred software, including Autodesk AutoCAD, AutoCAD Electrical, and AutoCAD Raster Design; Bentley Descartes, MicroStation, and Substation; and SCADA Systems Elecdes. Our design team has developed large libraries of blocks, cells, tables, and other useful tools to aid in our designs. These tools help our designers and drafters produce high-quality drawings with greater efficiency.

TYPICAL DESIGN AND DRAFTING DRAWINGS

Our extensive experience and drafting resources let us provide the following services to save you time and money and enable you to use your resources more productively:

- AC and dc schematics
- One-line diagrams
- Wiring diagrams
- Panel layout drawings
- Logic schematics
- Communications and network drawings
- Substation layouts and site plans
- Civil substation design drawings
- Demolition and removal design conversion
- Shop drawings
- Retrofit drawings
- Paper-to-electronic file conversion

GOVERNMENT ENGINEERING SERVICES

The SEL Government Engineering Solutions (GES) team understands the unique demands of government projects and offers the industry's best people, products, technology, and services. We offer engineering services and product solutions for government agencies, military installations, and navy ships to create a safer work environment and a more reliable and economical electric power system. Our engineers' many years of experience in the power industry allows them to easily translate your needs into workable solutions.

selinc.com/solutions/government-services

PROTECTION SERVICES

SEL experts can perform fault, system protection and coordination, and arc-flash studies; recommend protection schemes to match your system and goals; and develop and program relay settings.

AUTOMATION SERVICES

GES automation services include communications architecture design, the design and programming of HMIs for small- to large-scale systems, and the development and programming of communications and logic processor settings.

MICROGRID SYSTEMS

SEL microgrid systems reduce energy costs and emissions through optimized resource management. Our microgrids ensure uninterrupted energy delivery with robust cyber-security and physical security. Our systems control and manage microgrids from 1 MW to more than 1 GW by using a flexible and expandable architecture.

APPLICATION SERVICES

Our team reviews system designs and settings to reduce equipment and operational costs while increasing system performance and functionality. We can select the SEL products best suited to your power system protection and automation requirements.

FIELD SERVICES

The SEL GES team can:

- Upgrade aging infrastructure.
- Perform engineering work that requires a specialized workforce of cleared personnel.
- Provide onsite commissioning support from trained technical staff.
- Support or perform SEL product field testing.
- Analyze event reports to determine ways to improve system performance and increase reliability.
- Provide application-specific training for operations and engineering staff.
- Increase system performance and functionality.

GSA-APPROVED PRODUCTS AND SERVICES

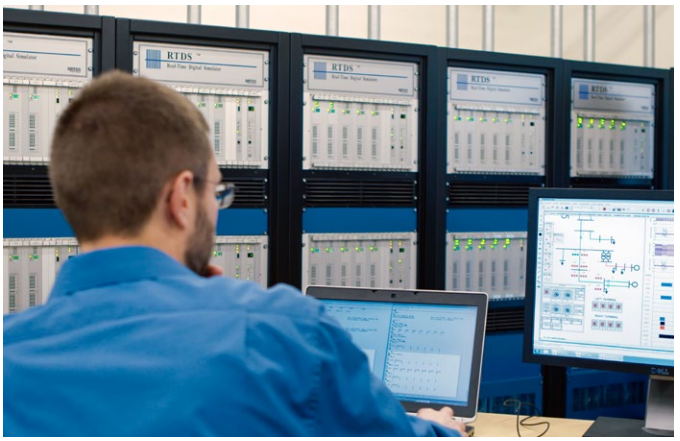
The SEL General Services Administration (GSA) contract provides federal agencies with access to many SEL products and services. A GSA purchase from SEL is simple. Government customers can order directly from SEL by including contract number GS-07F-0123N on their purchase order or through GSA Advantage!, GSA's online shopping and ordering system.

GSA Schedule
Contract: GS-07F-0123N

ENGINEERING STUDIES AND SIMULATION SERVICES

SEL Engineering Services conducts power system studies using simulation software. Our experienced team of engineers has the software and equipment necessary to model any power system and operating scenario. The results of these studies increase power system awareness or confirm reliable performance. With this insight and analysis, you can improve performance, ensure safe operation, and optimize device settings in your system.

selinc.com/solutions/system-modeling



PROTECTION STUDIES

Protection studies are important for identifying deficiencies and developing improvements to ensure a reliable electric power system. Our protection studies can improve relay coordination and reduce system outages. We review or build models to determine the system impacts during a faulted condition. To model the entire network, we use software applications, such as Electrocon International's Computer-Aided Protection Engineering (CAPE), AspenTech's software suite, and solutions from SKM Systems Analysis, EasyPower, and ETAP. We then compare model results and calculated values against equipment ratings to verify that the system is protected and operating safely.

Our protection study services include the following:

- Real and reactive (VAR) power flow and optimization
- Voltage drop and regulation analysis
- Short-circuit analysis
- Circuit breaker and bus rating evaluation
- Protection coordination, settings, and conversions
- Arc-flash hazard analysis
- Harmonic and power quality assessment
- Power factor improvement
- Transient stability analysis

HARDWARE-IN-THE-LOOP (HIL) TESTING

HIL testing improves power system reliability and reduces the costs associated with real-time transient power system testing. Our engineers build a model of your power system and integrate it with physical protection and control devices to simulate real-time operation. Validated models confirm that the simulated response to a disturbance or event reasonably matches the measured response to a similar disturbance. Incorporating these models with HIL testing demonstrates the performance of the protection and control scheme as well as its effect on the power system. We test scenarios for short-term versus long-term capacity limits to ensure a more accurate representation of a system's operations. Thorough modeling and understanding result in better system performance.

We have the largest commercial simulator for performing HIL testing in the United States, allowing our team to test many complicated scenarios, including the following:

- Communications-assisted tripping schemes
- Autosynchronizing schemes
- Load-shedding schemes
- Generation shedding and runback schemes
- Control schemes
- Islanding detection and decoupling schemes
- Remedial action schemes
- Phase-shifting transformer protection and control schemes
- Open-phase detection schemes

CUSTOM PANEL AND ENCLOSURE SOLUTIONS

We design, manufacture, test, and deliver custom protection, control, and metering panels, control cabinets, retrofit doors, and enclosures. We integrate multiple pieces of equipment (from SEL and other manufacturers) into a single assembly or kit, enabling one-stop shopping for parts and labor with a quick turnaround time. Our experts will work with you to understand your requirements and challenges and provide innovative, economical solutions built to stringent SEL quality standards.

selinc.com/solutions/custom-panel-solutions

selinc.com/solutions/custom-enclosure-solutions

COMPLETE DESIGN, MANUFACTURING, TESTING, AND COMMISSIONING SERVICES

To exactly meet your needs, we offer complete panel and enclosure solutions, from design through commissioning. We test the final implementation of every product or system before it ships, reducing your overall project costs and engineering time. This testing makes commissioning easier and faster.

COMPLETE PANEL SOLUTIONS

SEL custom panel solutions come with the following options and services:

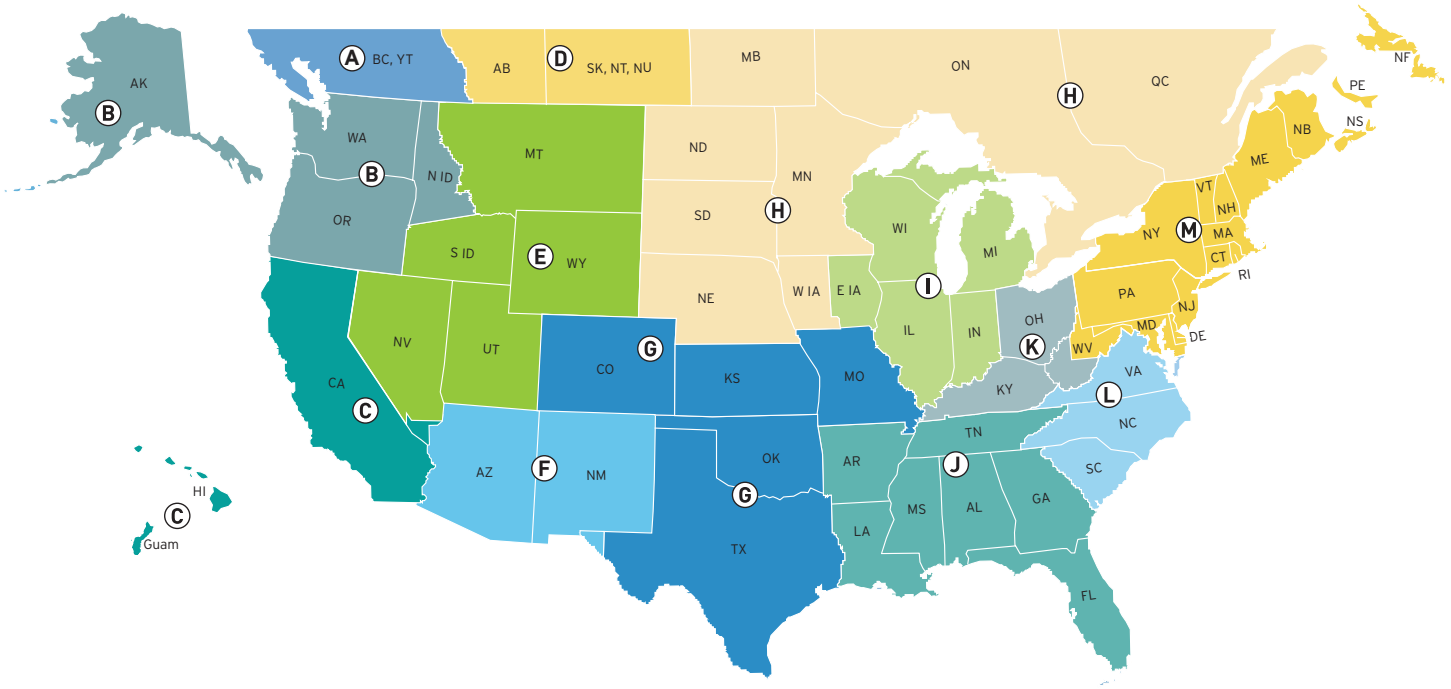
- Consulting and engineering design
- Testing and verification, including loading settings, functionality, point-to-point wire connectivity, ac/dc circuit operation, and Megger and HiPot testing
- Protection, automation, and control equipment manufacturing
- Field service
- Standard cabinet design
- Indoor and outdoor design
- Submersible cabinets for underground distribution and automation
- Delivery in 10—12 weeks
- Assigned project manager

COMPLETE ENCLOSURE SOLUTIONS

SEL custom enclosure solutions offer the following options and capabilities:

- Enclosures, racks, bezels, plates, portable enclosures, swing panels, and doors
- Custom adapters that integrate SEL equipment into your existing systems
- Prewired assemblies for easy installation and minimal field wiring
- Wiring conversion assemblies and terminals
- Fully assembled and wired test racks and simulator systems
- Easily extractable assemblies for SEL-700 and SEL-2400 series products
- Assembly for your pre-existing designs
- Stainless steel, mild steel, aluminum, fiberglass, and polycarbonates
- UL508A and CSA-C22.2 No. 14 certification

ORDERING AND CUSTOMER SUPPORT



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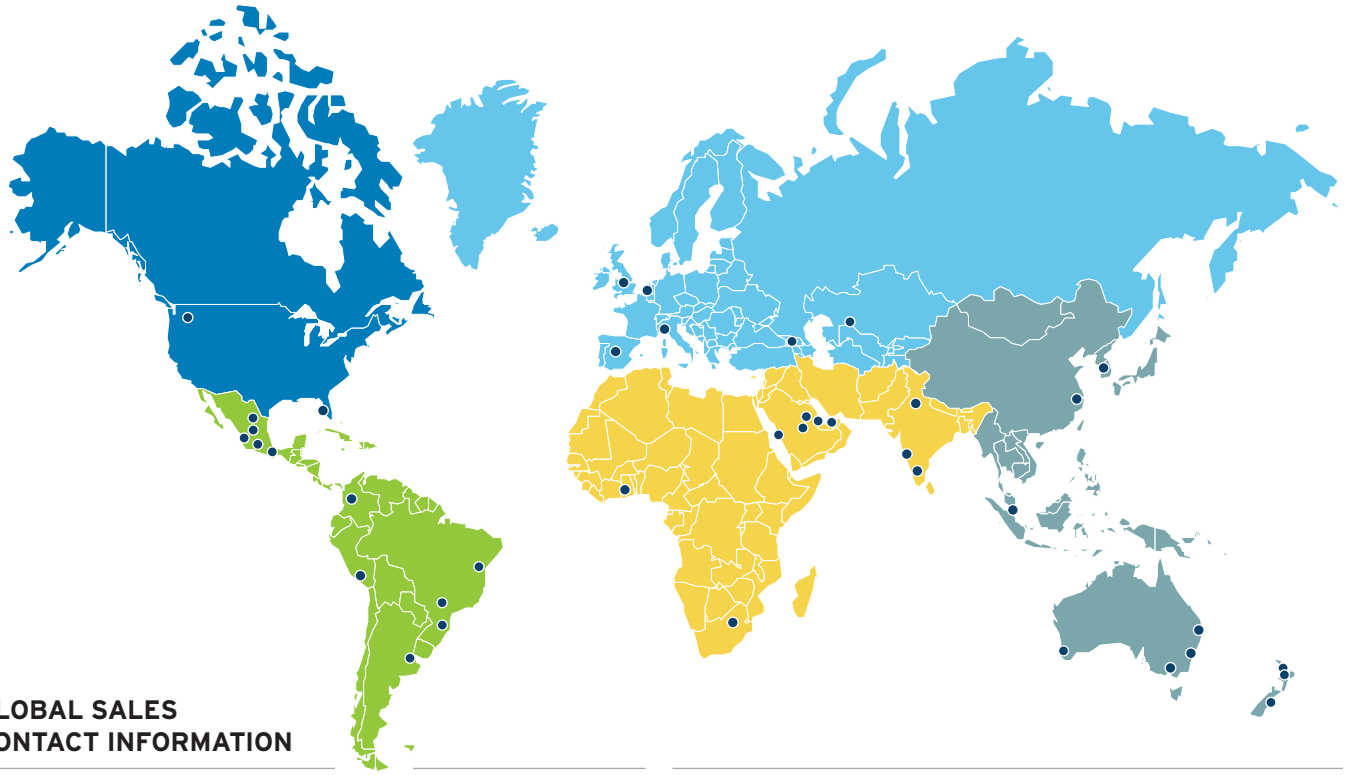

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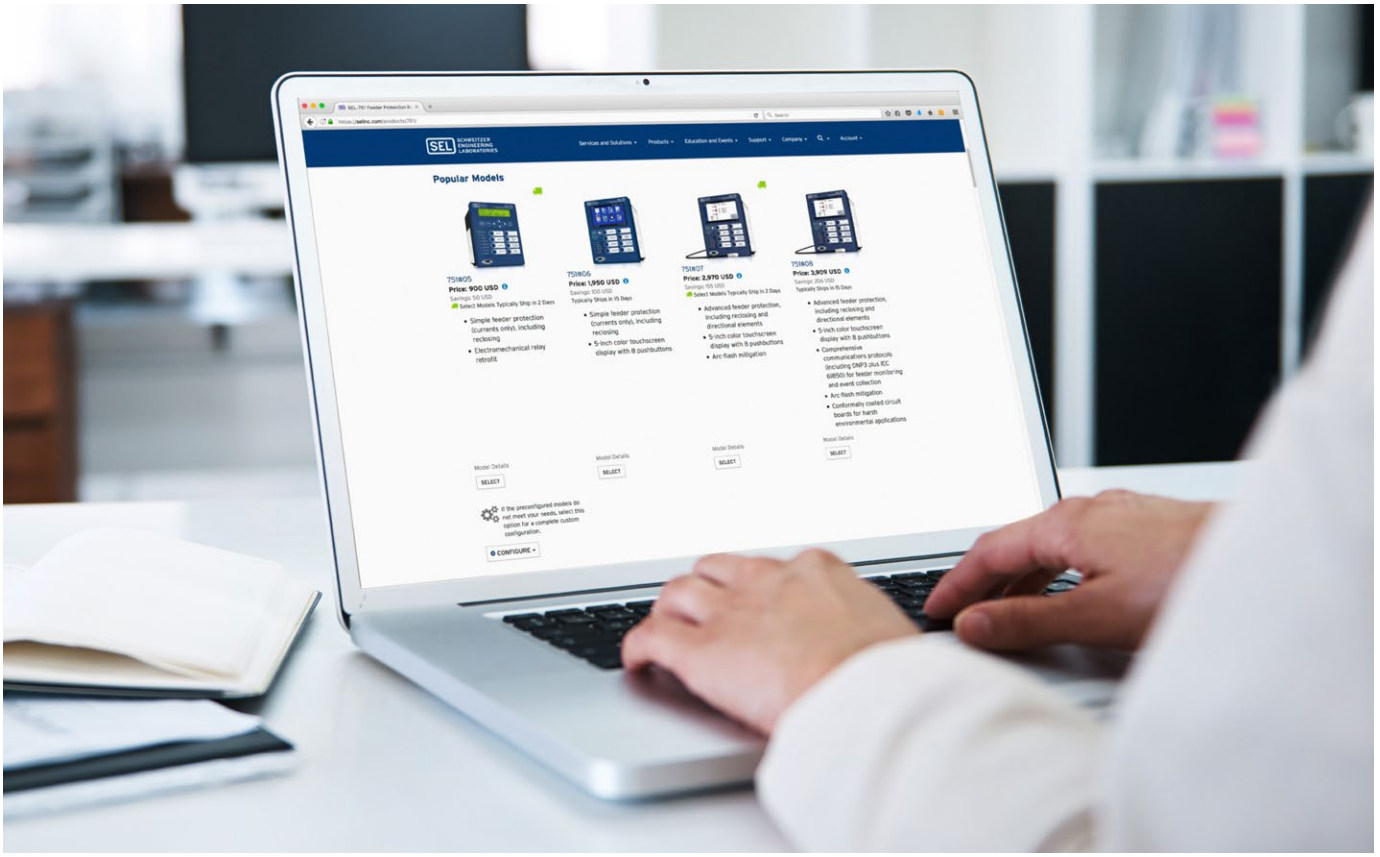
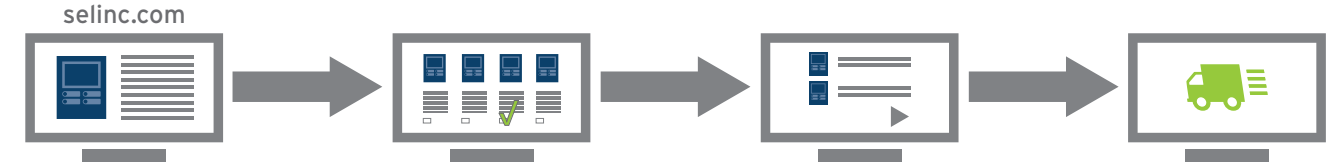
POPULAR MODELS SIMPLIFY ORDERING



The Popular Models program makes selecting and ordering SEL products simple, fast, and affordable. Through this program, SEL provides preconfigured product models for popular applications. Specific models offer discount pricing and/or ship from stock, typically in 2 business days.

The popular models are displayed on the webpage for each SEL product, and the webpage clearly shows the technical details and popular applications for each model. You can order these models directly online or through your SEL sales representative.



EXAMPLE POPULAR MODELS FOR THE SEL-751 FEEDER PROTECTION RELAY

APPLICATION DETAILS	CURRENT INPUTS	ITEM NO.		PRICE	
Simple feeder protection, including reclosing and electromechanical relay retrofit.	1 A phase/1 A neutral	751#0501		$900 USD	
	5 A phase/5 A neutral	751#0502		$900 USD	
Simple feeder protection, including reclosing, a 5-inch color touchscreen display, and 4 pushbuttons.	1 A phase/1 A neutral	751#1201		$1,450 USD	
	5 A phase/5 A neutral	751#1202		$1,450 USD	
Advanced feeder protection, including a 5-inch color touchscreen display and 8 pushbuttons.	1 A phase/1 A neutral	751#1001		$2,425 USD	
	5 A phase/5 A neutral	751#1002		$2,425 USD	
Advanced feeder protection, including reclosing and directional elements, a 5-inch color touchscreen display, 8 pushbuttons, and arc-flash mitigation.	1 A phase/1 A neutral	751#1101		$3,125 USD	
	5 A phase/5 A neutral	751#1102		$3,125 USD	

For a complete popular models listing, visit selinc.com/products/popular

Select models typically ship in 2 days

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